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ORIGINAL ARTICLES.

THE MAMMALS OF MADAGASCAR.

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Organic beings are not scattered broadcast over the earth's surface without regularity or arrangement, as the casual observer might suppose, nor are they distributed according to the variations of climate or of any other physical external agent, although the latter have, unquestionably, much influence in modifying their forms. But each species (or assemblage of similar individuals), whether of the animal or vegetable kingdom, is found to occupy a certain definite and continuous geographical area on the earth. In like manner, each genus, or assemblage of species, each family, or assemblage of genera, and each order, or assemblage of families, may be said to be subject to similar laws, as regards its geographical distribution,—although, as might have been supposed, the areas occupied by the higher groups are usually larger, and in some cases co-extensive with the earth's surface.

It thus happens that the various parts of the world are characterized by possessing special groups of animals and vegetables, and that, as a general rule, such tracts of land as are most nearly contiguous have their Faunæ and Floræ most nearly resembling one another; while, *vice versâ*, those that are farthest asunder are inhabited by most different forms of animal and vegetable life. When any exception to this rule occurs, and two adjacent lands possess dissimilar forms, or two regions far apart exhibit similar forms, it is the task of the student of geographical distribution to give some reason why this has come about, and so to make the "exception prove the rule."

In the present paper I propose to devote a short space to the examination of one of the best known and strangest of these anomalies

in geographical distribution—namely, that presented to us by the Fauna of the Island of Madagascar. Madagascar being immediately contiguous to the eastern coast of Africa, and separated from it by a channel in one place only some 200 miles across, in which, moreover, there are several intermediate islands, while it is very far removed from India and America, ought, according to generally-received rules, to exhibit a Fauna of a purely African type. But this, as is well known to naturalists, is not the case. The numerous Mammals of the orders Ruminantia, Pachydermata, and Proboscidea, so characteristic of the Æthiopian Fauna, are entirely absent from Madagascar. The same is the case with the larger species of Carnivora, which are found throughout the African continent, but do not extend into Madagascar. Again, the highly-organized types of Quadrumana, which prevail in the forests of the mainland, are utterly wanting in the neighbouring island, their place being there occupied by several genera of the inferior family of *Lemurs*. In the like manner, I shall be able to show that similar irregularities prevail to a greater or lesser extent in every other part of the series of Mammals, and that, in short, the anomalies presented to us by the forms of life prevalent in this island are so striking, that claims have been put forward in its favour to be considered as a distinct primary geographical region of the earth.*

But let us take the Orders of Mammalia as they are generally recognized, one by one, in order that we may examine more carefully the affinities of each genus of them included in the list of Madagascarian Mammals. To do this, it will be most convenient to refer to the catalogue of the Vertebrates of Madagascar lately published by M. François Pollen, in the 'Nederlandsch Tijdschrift voor de Dierkunde;'† this being the only general article bearing upon the subject that has yet appeared. M. Pollen's list is a compilation for his own use, as being about to visit Madagascar, of what has been recorded by previous authorities on the subject. Amongst such authorities, the most important, as regards Mammals, is certainly an article by M. Victor Sganzin, in the third volume of the 'Memoirs of the Society of the Museum of Natural History of Strasburg.' M. Sganzin was the commandant of the French settlement of Sainte-Marie, on the north-east coast of Madagascar, in 1831 and 1832, and obtained on that island and on the adjoining coast of Madagascar proofs of the existence of about a hundred Vertebrate animals, concerning which he gives us notes, without, however, in many cases, any precise determination of the species. Long before his time, it is true, De Flacourt and Sonnerat

* The most natural primary divisions of the earth as regards Zoology are, as has been shown in the 'Journal of Proceedings of the Linnean Society' (Zoology), ii. p. 130, and elsewhere, (1) The *Neotropical* region, comprising South America, Mexico, and the West Indies; (2) The *Nearctic*, including the rest of America; (3) The *Palæarctic*, composed of Europe, Africa north of the Sahara, and Northern Asia; (4) The *Æthiopian*, which contains the rest of Africa, Arabia, and Madagascar; (5) The *Indian*, consisting of Southern Asia and the western half of the Malay Archipelago; and (6) The *Australian*, which comprises the eastern portion of the Malay Archipelago, Australia, and the Pacific Islands.

† 'Nederlandsch Tijdschrift voor de Dierkunde,' Amsterdam, 1863, vol. i. p. 277.

had published narratives of their voyages to Madagascar, and the latter had made known to science several of the most remarkable types of the island;* but neither of these explorers has furnished any general indications as to the character of its Mammalian Fauna. In 1833, three French naturalists — Bernier, Goudot, and Rousseau — visited Madagascar, and it is to the labours of these energetic collectors on the eastern coast, and to those of Dr. W. Peters, of Berlin, on the western coast, that science is chiefly indebted for the progress that has lately been made towards the compilation of a list of the Mammals of this island, which, however, as far as our present knowledge extends, only embraces some 49 species—namely, Quadrumana 28, Carnivora 5, Chiroptera 5, Rodentia 1, Insectivora 9, Pachydermata 1.

To begin then with the order Quadrumana, the most remarkable and most characteristic type of Madagascarian Mammals here presents itself at once at the head of the list. The Lemurs are universally recognized among naturalists as forming a separate and distinct group of Quadrumanous Mammals. And of the Lemurs nearly thirty different species, embracing eight generic forms, are found in Madagascar, whilst all Africa only contains some eleven or twelve species of these animals, and the Indian region not more than three. This will be better seen by the subjoined table, in which the distribution of the genera of the family of Lemurs and the approximate number of the known species of each genus are given—

Table of the Distribution of the Lemuridæ.

Sub-family.	AFRICA.	MADAGASCAR.	ASIA.
Indrisinæ		1. Indris (2) † 2. Propithecus (1) 3. Avahis (1)	
Lemurinæ	8. Perodicticus (2)	4. Lemur (16) 5. Hapalemur (2) 6. Lepilemur (1) 7. Chirogaleus (2)	9. Nycticebus (2) 10. Loris (1)
Galaginæ	12. Galago (9)	11. Microcebus (2)	
Tarsiinæ			13. Tarsius (1)

Moreover, as the whole number of Mammals at present known to exist in Madagascar does not amount to fifty, we have this very remark-

* De Flacourt's 'Histoire de la Grande Ile de Madagascar,' and Sonnerat's 'Voyage aux Indes Orientales.'

† *N.B.*—The numbers in figures placed after the generic names in the table give the (in some cases approximate) number of species of the genus. Until very recently but one species of *Indris* was known to science; but M. Vinson has lately discovered, and described in the 'Annales des Sciences Naturelles' (Zool. xix. p. 253), a second from the forest of Alanamazoatrao—which he has proposed to call *Indris albus*.

able fact—quite unparalleled, as far as is hitherto known, in any other Fauna—that nearly two-thirds of the whole number of known species of the Mammals of this island are members of one peculiar group of Quadrumana.

Again, when we come to examine the *Lemuridæ* of Madagascar, and to compare them with their brethren in Africa and India, we find that they present us with no less than eight different generic types—all distinct from those found in the two latter countries.

The genera *Indris*, *Propithecus*, and *Avahis* constitute a section of *Lemuridæ* per se, easily distinguished from the rest of the family by having only five molar teeth on each side of the jaw, and only two (instead of four) inferior incisors. No genus with this form of dentition is found either in Africa or Asia. The true *Lemurinæ* are also most fully developed in Madagascar, the typical genus *Lemur* being numerous in species, and, as is stated by travellers, likewise in individuals. In Africa this sub-family is represented by the abnormal form *Perodicticus*—a recently-discovered second species of which is likewise considered by Dr. Gray* as entitled to generic rank. In India two allied genera of Lemurinæ are found—*Nycticebus* and *Loris*—likewise difficult to connect satisfactorily with the more typical members of the group, but presenting many indications of alliance to *Perodicticus*.

The third sub-family of the Lemuridæ is essentialiy African—consisting of the genus *Galago*, with eight or nine species dispersed over various parts of that continent, while *Microcebus*, with two or three imperfectly-known species, takes its place in Madagascar.

The next form we meet with as we descend the series of Madagascar Mammals, is the celebrated Aye-aye (*Chiromys Madagascariensis*), an animal so anomalous in its structure, that although it has been now conclusively proved that its nearest allies are amongst the Lemurs,† even the illustrious Cuvier referred it to the widely-distant order of Rodents. The Aye-aye is pronounced by Professor Owen to be more nearly allied to some of the African Galagos than to any other living form. It may be, however, remarked that the Tarsier of the Indian Archipelago (*Tarsius spectrum*) presents certain points in its structure which likewise show a remote affinity to this extraordinary type.

The second order of Mammals—the Bats or Chiroptera, have, as far as our present knowledge goes, only five representatives in Madagascar. Two of these belong to the Frugivorous family *Pteropodidæ*—and curiously enough to the *Indian*, not to the African section of the group. One of them indeed (*P. Edwardsii*) is so clearly allied to the common *Pt. medius* of continental India, as to have been very constantly confounded with it. ‡

The three known species of insectivorous Bats of Madagascar (*Rhinolophus Commersonii*, *Vespertilio Madagascariensis* and *Emballonura*

* See Dr. Gray's 'Revision of the Species of Lemurian Animals.' Proc. Zool. Soc. 1863, p. 129.

† See Prof. Owen's Memoir 'On the Aye-aye.' Trans. Zool. Soc. v. pt. 2 (1863).

‡ As to the real distinctness of these species, see Peters, 'Zool. Reise n. Mossambique,' vol. i. p. 22.

Madagascariensis) supply us with no very precise indications as to their geographical affinities.

In the next order of Mammals the *Insectivora*, of which nine species are known to inhabit Madagascar, we again find a very peculiar group of types, consisting of the genera *Centetes*, *Ericulus*, and *Echinogale*. These little animals, though generally associated with the Hedge-hogs (*Erinaceus*), to which in their external appearance they present much resemblance, have been recently declared by Dr. Peters—who has devoted much attention to the *Insectivora*—to be most nearly allied to the American genus *Solenodon!* * So to find their nearest affines we have to cross the whole (present) continent of Africa and the Atlantic Ocean to the West Indian Islands, where the only two known species of *Solenodon* occur.

Besides the *Centetinæ* the Insectivora of Madagascar consist of two species of Shrew (*Sorex*)—a form widely distributed in the Old, and northern portion of the New World, and a singular little animal, at present very imperfectly known, which was described by M. Doyère in 1835 under the name of *Eupleres Goudoti*. The *Eupleres Goudoti* is stated to agree in its dentition with the moles (*Talpa*), to which genus also it would likewise seem to present some resemblance in its habits; but its general external conformation is much more like that of a small vermiform Carnivore, and its describer considers it to constitute the type of a new family of *Insectivora*, leading off towards the Carnivora.

The order Carnivora again presents us with three types peculiar to the island—*Cryptoprocta*, *Galidia* and *Galidictis*. These, however, all belong to the family *Viverrinæ*—a group peculiar to the Old World, and of which several allied genera inhabit the adjoining parts of Africa. It is not, therefore, necessary to look "across the Atlantic" for the nearest relatives to the Madagascarian Carnivora. Strangely enough, the nearly universally distributed types *Felis* and *Canis* seem utterly unrepresented in this Fauna.

Of Rodents only one species, I believe, has yet been registered as found in Madagascar. This is a squirrel of the genus *Sciurus*—which, as far as it is known, exhibits African affinities. Rats and mice, indeed, there are in Madagascar, as in nearly every other habitable portion of the globe where man has penetrated, but these are of the well-known European species, and must be put into the same category as the cats, dogs, and oxen which have been introduced into and flourish in the island.

The important order of Ruminants, which is so greatly developed on the opposite coast of Africa, appear to be wholly wanting in the indigenous Fauna of Madagascar. While Antelopes of numerous species abound in every part, whether plain or forest, of the adjoining continent, and the Giraffe and Buffalo are likewise everywhere characteristic features of the Æthiopian Mammal-fauna, not one of those creatures is known to occur in Madagascar, and this fact alone would serve to

* Cf. Peters, 'Ueber die Saügethier-gattung, *Solenodon*.' Abh. Acad. Berlin, 1863.

mark out the wide difference between these two creations as they stand at present. The same is nearly the case as regards the next order—that of Pachyderms. The *Hippopotamus*, so abundant on the opposite coast of Mozambique, is not found in Madagascar. Had Madagascar ever formed part of Africa this would hardly have been the case. The genus *Equus*, well represented in Southern Africa by the Zebras and Quaggas, the Hyrax and the Rhinoceros, is likewise wanting; and of the Artiodactyles only a single species—namely, the South African Riverhog (*Potamochœrus Africanus*)—is stated to inhabit Madagascar. But although M. Sganzin has positively identified this species as a Madagascarian animal, I cannot but think it rather doubtful; in the first place, because this is the *only* exception to the general rule of specific (and almost generic) difference between the Mammals of Madagascar and Africa; and secondly, because Dr. Peters tells us he could obtain no indications of the existence of this Pig upon the opposite coast of Mozambique. However, until the contrary is proved, it is only fair to assume M. Sganzin's statement to be correct, and to include this Riverhog in the list of Madagascarian Mammals.

Having thus given a cursory view of some of the more salient features of the Mammal-creation of Madagascar let us see what deductions we can gather from them as to its origin—taking, of course, for granted, the derivative hypothesis of the origin of species—at present, the only theory by which the otherwise inexplicable facts of geographical distribution can be explained. Of course it would be more satisfactory in a case like the present to have before us a summary of the knowledge we possess concerning every part of the Fauna and Flora of Madagascar, but as space does not permit this, let us see what we can make out from the Mammals alone.

The following deductions may, perhaps, be arrived at from what we have before us:—

1. Madagascar has never been connected with Africa, *as it at present exists*. This would seem probable from the absence of certain all-pervading Æthiopian types in Madagascar, such as *Antilope*, *Hippopotamus*, *Felis*, &c. But, on the other hand, the presence of Lemurs in Africa renders it certain that Africa, as it at present exists, contains land that once formed part of Madagascar.

2. Madagascar and the Mascarene Islands (which are universally acknowledged to belong to the same category) must have remained for a long epoch separated from every other part of the globe, in order to have acquired the many peculiarities now exhibited in their Mammal-fauna—*e.g. Lemur, Chiromys, Eupleres, Centetes*, &c.—to be elaborated by the gradual modification of pre-existing forms.

3. Some land-connection must have existed in former ages between Madagascar and India, whereon the original stock, whence the present Lemuridæ of Africa, Madagascar, and India are descended, flourished.

4. It must be likewise allowed that some sort of connection must also have existed between Madagascar and land which now forms part of the New World—in order to permit the derivation of the *Cente-*

tinæ from a common stock with the *Solenodon*,* and to account for the fact that the Lemuridæ, as a body, are certainly more nearly allied to the weaker forms of American monkeys than to any of the Simiidæ of the Old World.

To conclude, therefore, granted the hypothesis of the derivative origin of species, the anomalies of the Mammal-fauna of Madagascar can best be explained by supposing that, anterior to the existence of Africa in its present shape, a large continent occupied parts of the Atlantic and Indian Ocean stretching out towards (what is now) America on the west, and to India and its islands on the east; that this continent was broken up into islands, of which some became amalgamated with the present continent of Africa, and some possibly with what is now Asia—and that in Madagascar and the Mascarene Islands we have existing relics of this great continent, for which as the original focus of the "*Stirps Lemurum*," I should propose the name Lemuria!

EXPLANATION OF THE PLATE.

The accompanying sketch by Mr. Wolf will serve to illustrate the more remarkable types of the Mammal-kind of Madagascar. On the summit of the trees are Lemurs of different species (*Lemur leucomystax*, *L. varius*, *L. catta*, and *L. xanthomystax*). In the centre is the Aye-aye; on the ground to the left is one of the remarkable Carnivores of the island (*Galidictis vittata*) staring at it; on the right is the little *Echinogale telfairi*, endeavouring to make its escape from such an extraordinary assemblage. In the background may be seen the celebrated Traveller's-tree (*Urania speciosa*), and other marked forms of Madagascarian vegetation.

ON THE SOLAR SPOTS.

By SIR JOHN F. W. HERSCHEL, Bart., K.H., D.C.L., F.R.S.

THE physical constitution of the sun, and the nature of the source from which its expenditure of light and heat is supplied, must be regarded as by far the most important astronomical problem which remains unresolved, connected as it is not only with the maintenance of all animated existence, but as a matter of speculative interest with every branch of physical science; since there is not one which has not to be laid under contribution in support or confutation of the various theories which have been, and will probably be henceforward, proposed to account for it. Apart from the knowledge of the dimensions and mean density of the sun which we derive from the great fact of planetary Astronomy, from its presumed connection with the Zodiacal light, and from the appendages to its disc, which become visible in total eclipses, and which demonstrate the existence of a solar atmosphere extending to a vast distance beyond the general

* This single case, it must be reasonably allowed, would be hardly sufficient for the foundation of so startling a supposition; but the presence in Madagascar of American forms of Serpents (*Xiphosoma*, *Heterodon*, *Philodryas*, and *Leptodeira*), of Iguanoid Lizards, and even of American Insects, necessitates some such hypothesis.

luminous surface or *photosphere*, we have little or nothing to guide us in this inquiry but the telescopic examination of its surface, which reveals to us, besides a general texture of a very peculiar kind, the existence of dark spots, temporary in their duration, holding no fixed position with respect to its poles and equator, and presenting, in other respects, no analogy to those appearances on the planets which indicate the existence of local peculiarities on their solid globes, or of conditions in their atmosphere as to clouds and clear sky which obtain in our own. These spots, ever since their complete and recognized discovery *as such* by Fabricius, Galileo, and Scheiner, in 1611 (for though occasionally seen before the invention of the telescope, they had hitherto been taken for Mercury or Venus in inferior conjunction), have always been examined with great though desultory interest: and it is only since the year 1843, when Schwabe announced his important discovery of the periodicity of their occurrence, that the desirableness of keeping up an unbroken record, *a complete diary*, in fact, of the appearances presented by the solar disc, supplying by observations in different places the lacunæ left by cloudy weather in any one, has been recognized.

During the years antecedent to this epoch, however, a vast amount of interesting information had been gathered as to their dimensions and forms, their *penumbræ* and *umbræ* (or, as they were sometimes called, nuclei,) the *faculæ* or veins of brighter light which accompany and surround them, or which exist detached and remote from spots; their law of distribution over the surface; their generation, duration, and extinction; their appearances, disappearances, and reappearances, as carried round with the globe of the sun by its rotation on its axis, &c: all particulars very necessary to be borne in mind in reference to their physical explanation, as well as to what may be called their descriptive history, and of which a brief *résumé* may not be thought irrelevant as introductory to the more especial subject of this notice, which is intended to draw attention to the conclusions which may be deduced from certain recent observations of their movements in longitude and latitude in reference to the equator of the sun's globe.

But, first, we have a few words to say on the conditions requisite for viewing the sun with effect, and for delineating or photographing its spots, which will not be thought out of place by many of that numerous class of observers who, with telescopes or other apparatus competent to do good service, are without much experience in this special line of observation. A very convenient mode of viewing them is by projecting the image of the sun in a darkened room, on a white screen. This, in its rudest form, was the method followed by Kepler, who used only a small hole in a shutter, without a lens, and was thus enabled to see a spot on November 29, 1606, and another on May 18, 1607 (o. s.), which he also took for Mercury (then, however, not in transit, and not even in inferior conjunction). If a lens be used to bring the rays to a focus, the image, of course, is much improved. Still more if it be achromatic: and if in place of a single lens a good telescope of moderate focal length be used, and the eye-piece drawn out somewhat beyond the focus for parallel rays, an image of a high

degree of perfection is procured, which may be impressed photographically or delineated manually. The former is the mode practised at the Kew Observatory by Mr. De La Rue, and we believe by most other helio-photographers: the latter is understood to be the origin of those exquisite drawings laid before the Royal Astronomical Society by Mr. Howlitt. One improvement only seems yet wanting to render either of these modes of procedure as satisfactory as actual vision through the telescope—*viz.* in the place of the ordinary telescopic eye-piece to substitute an achromatic and aplanatic object-glass of *short focus* and sufficiently large aperture, having the radii of the surfaces of its two lenses calculated on the principles laid down in my paper ('Phil. Trans.,' 1821) for the construction of such an object-glass. The radii so calculated afford a lens, aplanatic not merely for parallel rays, but for all distances of the radiant point, so that when inverted, or placed with its flint lens towards the light, and used as a microscope, it produces *neither colour nor spherical aberration*, and is thus excellently fitted for projecting a magnified image, perfect not only as to the form, but as to the *colour*, of the spots, and on a scale of any desired enlargement, by a mere change of focus and corresponding alteration of the screen's distance.

When the telescope is used *as* a telescope, the great brightness and intense heat of the sun require to be subdued, to make observation possible. It is a common mistake to suppose that this can be done by merely contracting the aperture of the object-glass by a circular diaphragm placed before it. In practice this is fatal to distinct vision. *Cæteris paribus*, in telescopic vision, the sharpness of definition is in the direct ratio of the angle (within moderate limits) which the object-glass subtends at its focus. Any attempt to evade this law by stopping out the light by concentric *annuli* will be found to issue in worse confusion. To use the full aperture of the telescope is of paramount necessity either in viewing the sun or planets. If the extinction of the light is effected by coloured glasses, the best combinations I have yet found are: 1st, that of two plane glasses of a shade between brown and violet, with one of a grass-green hue interposed: or 2nd, of two green glasses, with a blue one coloured by cobalt between them. These allow scarcely any rays of the spectrum to pass but the yellow and less refrangible green; and they cut off almost all the heat. The *perfection* of vision is attained by using only the extreme red rays; but glasses which transmit these cannot be used on account of the heat they allow to pass. Whatever combination of glasses be used, they are, however, apt to crack and fly to pieces through the heat which they *do* intercept. Hence the necessity of either limiting the field of view by a metal screen with a small hole *in the focus* of the object-glass, as recommended for trial by Wilson, in 1774, and as practised with excellent effect by Mr. Dawes; or of some construction of the telescope itself, which, in the act of forming the image, shall suppress a very large percentage of the whole incident light, without preference of colour. Such is the object of the "Helioscope" described in my "Cape Observations," *

* (1847), page 436.

which utilizes for the formation of the image only about one 900th part of the incident rays, and if a greater diminution be desired, it may be obtained by a polarizing eye-piece. I have reason to believe that this construction will ere long receive a full and satisfactory trial at the hands of one of our most distinguished solar observers and practical mechanists. In default of a glass-reflecting speculum such as this construction requires, and of the prism recommended for a second reflexion, I have used (*vide locum citatum*) a plane glass, roughened at the back, interposed obliquely, so as to intercept the converging rays before forming the first image, and reflect them through the eye-piece of a Newtonian telescope with great advantage. Mr. Hodgson* has recommended, and used successfully, a similar contrivance, with a refracting one.

Spots on the sun have frequently been seen with the naked eye, by taking advantage of its proximity to the horizon, or of the intervention of light clouds. Instances of the kind are recorded by the annalists before the invention of telescopes—in A.D. 807 and 1160; and since by Galileo himself, by D'Arquier (April 15, 1764; January 30, 1767; June 6, 1763), by Sir William Herschel (April 17, 1779, September 2, 1792), &c. Only the bare existence of a spot, however, can be so discerned. No details of course can be distinguished. When viewed with telescopes, the spots are seen to consist of two very broadly distinguished shades of darkness: that of the interior and smaller portions, or *umbræ*, being so dark as to be called in common parlance black (considerably less so, however, than the body of Mercury or Venus seen in transit, or the moon during a solar eclipse); the exterior and larger (which usually, but not always, completely surrounds the *umbra*) of what would be termed in painting a half-shade, and therefore called the *penumbra*. Occasionally, but rarely in large spots, this is altogether absent. But whenever it exists the line of demarcation between the shades is sharp and unequivocal. So, at least, I have invariably found it, and whenever a gradation of tint from one to the other has been thought to have been perceived by other observers, I am disposed to attribute it to the optical mixture of the images of the ragged edges of the penumbra with the black ground on which they are projected on the retina arising from imperfect definition. The point is of extreme importance in the physical theory of the spots. So marked a distinction is altogether adverse to the idea of a luminous gas or fluid, indefinitely miscible with, or soluble in, a non-luminous transparent atmosphere; while it agrees with that of an aggregation of the luminous matter in masses of some considerable size, and some certain degree of consistency, suspended or floating *at a level determined by their specific gravity* in a non-luminous fluid; be it gas, vapour, liquid, or that intermediate state of gradual transition from liquid to vapour, which the experiments of Cagniard de la Tour have placed visibly before us; *and which, when we consider the high temperature throughout the solar atmosphere, and the enormous pressure at the surface of its solid globe (if it have any such) we cannot but believe to be realized on the grandest scale in solar physics.* And this is strongly corroborated by a certain streaky

* Royal Astronomical Society's Monthly Notices, Dec. 8, 1854.

or furrowed appearance in the penumbræ, directed always radially to or from the centre of the umbra, as if rifted, and allowing the black ground on which they are seen projected to appear through the chinks (see Fig. 3): an appearance likened in certain cases by Mr. Dawes to "bits of straw," and by Mr. Nasmyth asserted to be distinctly referable to certain fusiform, lanceolate, or "willow-leafed" objects of definite size and shape, superposed in general like scales, covering one another partially (see Fig. 5), but in the penumbræ, radially arranged, of which he conceives the whole luminous surface of the sun to consist.* It is not meant to assert that either the penumbræ or umbræ are devoid of all gradation of light. Both have darker and lighter shades, but (especially as regards the umbræ) within far narrower limits of variation. Within the latter, indeed, which, up to a recent period, most observers, after Sir William Herschel, had agreed to regard as openings through which the dark body of the solar globe could be seen, Mr. Dawes, by the application of his diaphragm eye-piece already mentioned, has disclosed the existence of a third, and still deeper *definite* shade of darkness, constituting, as it were, a nucleus, or umbra of the second order (see Fig. 3), to which we propose henceforward to restrict the name of "nucleus." Between the penumbra, too, and the general brightness of the photosphere, a suddenness of transition exists, less marked, indeed, than that between it and the nucleus, and less rigidly preserved, but yet on the whole exceedingly striking. And the whole series of phenomena strongly suggests the notion of three envelopes or veils between the exterior transparent atmosphere and the sun itself, the two outer being luminous, the inner probably only seen by reflected light;—each capable of being partially removed, either by some emanation or upsurging movement from below, or denudation from above, leaving a central opening, over which, when the denuding cause has ceased its action, the luminous strata tend to return, and spread themselves equally. Even in such central opening, however, the darkness is probably only relative, and, could the surrounding glare be completely extinguished, the light of the central space would probably equal or exceed that of the brighter incandescence of our furnaces. It is inconceivable indeed, that the actual surface of the solar globe (*if there be any such definite surface*), surrounded as it is by an *enceinte* of such a temperature as that of the photosphere, should be otherwise than in a state of the most vivid incandescence: and that it should appear no brighter than it does is not the least inexplicable feature of solar physics. Can it be that the interposition of mixed metallic vapours, each specifically opaque to definite rays of the spectrum between the body and the penumbral envelope may by their joint absorption, cut off nearly the whole of the light of the former? Ignited, transparent, and colourless liquids or gases, it should be observed, give off no light *from their interior*.

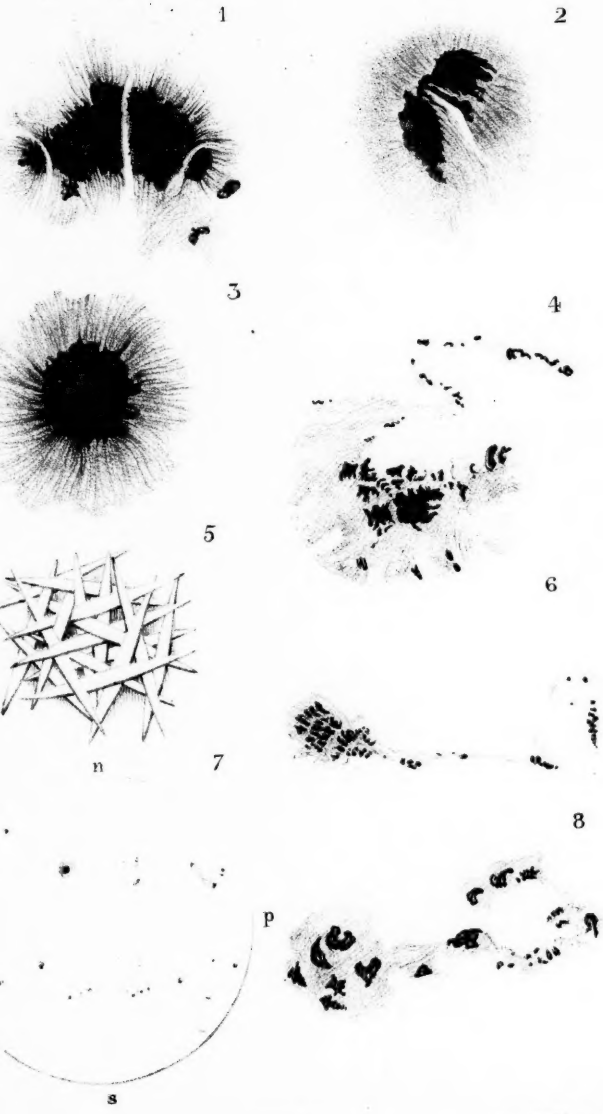
The forms of the spots are extremely irregular; of the penumbræ

* Other observers, as I have recently been informed, consider Mr. Nasmyth's "willow-leaf" figures as too slender and pointed, and liken the forms rather to that of rice-grains.

indeed excessively so. As there occur umbræ without penumbræ, so penumbræ occur without umbræ, but such are usually only branches or outlying portions of groups, or the remains of a spot in the act of obliteration when the umbra has disappeared. In the great majority of cases many umbræ are surrounded and connected into a group by a common penumbra. This indeed is almost always the case with large spots. The umbræ, when large, affect more compact and rounded forms than the penumbræ, and the interior *nuclei* of Mr. Dawes still more so. On the whole there is a certain tendency to the *bizarre* in all the forms, which though indescribable in words is highly characteristic. One of Mr. Howlitt's drawings offers a strange approximation to the complete form of a human skeleton. A form not uncommon, especially towards the subsidence of a period of solar activity, is that of a tadpole with a large irregular head consisting of a penumbra and several umbræ, and a curved penumbral tail dotted with smaller ones (see Figs. 4, 8). This form of spot has been noticed by some observers, among others by Picard in 1671, as recalling the outline of a scorpion (Fig. 6). The larger umbræ are often crossed (Fig. 1), or nearly crossed (Fig. 2), by narrow bridges of light, rarely penumbral, most usually of the full brilliancy of the photosphere, or even surpassing it. In many cases they are irregularly rounded on three sides, and sharply cut as if snipped by scissors on the fourth, and to such sharp edges there is often no penumbral border. Lastly, spots are much more commonly connected in groups than quite insulated, and very frequently affect linear sequences, oblique to the parallel of solar latitude in which they occur; the line of direction being towards a point in the sun's equator *preceding* the situation of the spot in longitude (see Fig. 7).

Large spots, or groups, are almost always attended by neighbouring *faculæ*, which are streaks, or vein-like appearances, more or less crooked and branching, of brighter light than the general photosphere. They are much more conspicuous, however, *near* the borders of the visible disc than towards its centre, a fact strongly indicative of their elevation, as ridges or heaps of the luminous matter, which so rising above the denser regions of the circumfused atmosphere, have their light proportionally less enfeebled by its absorption. On the other hand they are never traced fairly *up to* the actual edge of the disc—where the absorption of the solar atmosphere is so great as to extinguish (according to Chacornac) nearly half the light—a proof that their elevation is far from commensurate with the extent of that atmosphere, and that they are not identical with the "red flames" seen on the limb of the sun in total eclipses. Indeed the latter appear indiscriminately round every portion of the disc, whereas the faculæ are never seen in the sun's polar regions. Neither is the connection of the spots with faculæ one of reciprocity, for the latter are often seen where no spots exist.

When spots on the sun's surface are viewed from day to day, they are seen to undergo great changes in form, size, and relative situation *inter se*, as well as to be carried round by a common movement; evidently due to the sun's rotation on its axis in the same direction, and nearly in the same plane as that of the planetary movements; and



J.W.Herschel del.° Hanhart imp.t Edwin M.Williams Sc

FIGURES FOR SIR J. HERSCHEL'S PAPER, ON THE SOLAR SPOTS.

from this latter movement, by tracing the apparent paths of individual spots across the disc, the time of that rotation was early concluded, approximately by Galileo himself, and with more exactness by the use of micrometric measures by his successors—as well as the position of its axis in space, or, which comes to the same thing, the inclination of its equator to the ecliptic and the longitude of its ascending and descending nodes. As regards these latter particulars, the results arrived at by various observers and computists, especially the more modern ones (Lalande, Fixlmillner, Böhm, Laugier, and Carrington), are in as good accordance as could be expected, and may be stated at 7° 15′ for the inclination of the axis, and 73° 40′ for the longitude of the ascending node for 1850; so that the north pole of the sun's axis points nearly to the star π *Draconis*, and the south to α *Plutei*. As regards the time of rotation, however, the disagreement is more considerable, for a reason which will presently appear.

Few spots, and those only very large ones or groups of such, are permanent enough to be traced through more than one or two successive revolutions of the sun. Instances of three or four returns are extremely rare. Schwabe, however, in 1840, saw the same spot eight times in the middle of its course over the disc, having made seven full revolutions between May 11 and November 16. Single spots, or small groups, undergo such changes in a few days as to be hardly recognizable, and many originate and die out during a single transit. The origin of a spot when it can be observed, is usually traceable to some of those minute *pores*, or dots, which *stipple* the sun's surface, and which begin to increase, to assume an *umbral* blackness, and acquire a visible and at first very irregular and changeable shape. It is not till it has attained some measurable size that a penumbra begins to be formed, a circumstance strongly favouring the origination of the spot in a disturbance from below, upward;—*vice versâ*, as the spots decay, they become bridged across, the umbræ divide, diminish in size, and close up, leaving the penumbræ, which by degrees also contract and disappear. The evanescence of a spot is usually more gradual than its formation. According to Professor Peters and Mr. Carrington, neighbouring groups of spots show a tendency to recede from one another.

The changes undergone in a few hours by large spots, or among groups, are such as to alter visibly their shapes and relative situations, and from day to day to transform them entirely. Professor Wolf observed one on March 10, 1861, which in the short interval of 1h. 17m. underwent, not merely visible but enormous changes, altering its whole aspect. And when it is remembered that a single second on the sun's surface (seen from the earth) corresponds to 461 miles linear measure, and a square second (almost the *minimum visibile*) to upwards of 20,000 square miles, we need not to be told that such changes imply movements of a rapidity to which our fiercest hurricanes offer no approach; so that the term "viscous," which has been applied by some to the fluid in which the photosphere floats, is in the last degree inappropriate. Mr. Dawes and Mr. Birt have observed the umbræ of spots in some cases to rotate as it were slowly on their centres.

The earliest observers of the solar spots were led to notice the fact of their total absence in the circumpolar regions of the sun's surface, and we find it already remarked by Scheiner that their appearance is confined to a zone extending to 30° or 35° in latitude on either side of his equator. All subsequent observation has confirmed this. Only one fully-authenticated observation (by M. Peters, in 1846) is adduced of a spot in so high a North latitude as 50°, and a double one has been observed by Mr. Carrington in 44° S. The equator itself is, however, rarely visited by them, and this paucity usually extends over an equatorial zone, from 8° N. to 8° S. latitude. From these limits to 20° latitude on either side extends the region of their *most* frequent occurrence. Moreover it is no uncommon thing in very spotty states of the sun to observe some one parallel of latitude dotted out as it were on the disc by a more or less continuous line of spots extending across or nearly across the whole disc, and that occasionally in both hemispheres. (See Fig. 7.)

No one *meridian* of the sun, however, is found to be especially abundant in them, nor has observation yet pointed out any particular *locality* on that globe, at or near which a spot more frequently breaks out than at any other on the same parallel, a circumstance conclusive against their owing their origin to volcanic eruptions or any simply local causes.

The sun is not equally spotted at all times. Many months and sometimes whole years have elapsed without the *notice* of a spot. In others, for months, nay years together, they have been remarkable for number and magnitude. It seems to have been a very general belief up to the epoch of Professor Schwabe's observations already mentioned, that this variety was purely casual, and altogether irregular. But the evidence obtained by M. Schwabe, observing from 1826 to 1860, on an average 300 days per annum, during each of which the number of groups and single spots was registered, clearly established a periodicity. Thus, in 1833, 1843, 1856, very few groups were seen, and on nearly half the days of observation the sun was spotless; while in 1828, 1837, 1848, 1859, and 1860, the number of groups was extraordinary, and *not one* spotless day occurred; while the intermediate years exhibited a regular alternate increase and decrease. A period from ten to twelve years in duration was thus indicated. It became therefore exceedingly interesting to ascertain, by the collection and comparison of all the observations recorded of the sun's state since the first discovery of the spots, whether this alteration of periods of excitement and quiescence would be corroborated or not. This task (one of no slight labour) has been accomplished with extraordinary devotion and perseverance by Dr. Rudolf Wolf, Professor of Astronomy at Zurich, who in a series of Essays communicated to and published by the Zurich Society of Natural Philosophy, has collected from every available source the whole literature of the subject, and subjected the totality of the recorded observations to a most careful and searching scrutiny. In so doing he has been enabled to assign, on what appears to us sufficient evidence in general, and in most cases decisive, the following epochs of *minima*

of solar activity (as evinced by the production of spots), with the intervals elapsed between each, *viz.* :—

Minima, A.D.	Intervals.	Minima, A.D.	Intervals.
	Years.		Years.
1610·8	8·2?	1733·5	11·5
1619·0	15·0?	1745·0	10·7
1634·0	11·0	1755·7	10·8
1645·0	10·0	1766·5	9·3
1655·0	11·0	1775·8	9·0
1666·0	12·5	1784·8	13·7
1679·5	10·0	1798·5	12·0
1689·5	8·5	1810·5	12·7
1698·0	14·0	1823·2	10·6
1712·0	11·0	1833·8	10·2
1723·0	10·5	1844·0	12·2
1733·5		1856·2	

The mean interval is $11^{y}\cdot2$, or, considering that the two first epochs are necessarily somewhat uncertain, very nearly $11^{y}\frac{1}{5}$th, or nine complete periods in a century; and the mean epoch 1799·24, which is so nearly 1800·0, that as a convenient date for memory the commencement of the terminal year of each century may be taken as a starting point. The comparison of epochs of maximum activity leads to a similar conclusion as to the length of the average period; but these epochs are less definitely marked, and subject to greater deviations from their average places than the minima which, themselves, as is evident from the above synopsis, are subject to pretty considerable irregularities. Generally speaking there appears a tendency in the maxima to anticipate the middle time between the consecutive minima, the interval 11·11 being divided into two unequal sub-intervals of $4^{y}\cdot77$, and $6^{y}\cdot34$.

Professor Wolf estimates the solar activity on any day by adding together the number of individual *spots* counted on the disc and ten times the number of *groups*. This is to a certain extent arbitrary. But some rule must be adopted for calculation, and it would not be easy to propose one less open to objection. Taking the total so obtained for each day for the measure of that day's activity, and thence calculating the mean yearly activity, and the mean during each period, he has arrived at some very striking and remarkable conclusions, which may be thus stated. 1st. If a series of equal distances be marked off in a line to represent years, and on the middle of each an ordinate erected representing the mean annual activity, their extremities being joined by a curve; this will, of course, exhibit a series of waves averaging 11·11 years in breadth. Now it is found that the summits of these waves (and also their depressions) are of very unequal heights, and that (regarding their summits only) the curve connecting these exhibits again a series of larger waves, occupying, from summit to summit, a breadth of about 56 years, or (?) five times the length of the smaller period, the maximum value of *its* ordinate being nearly double of the minimum. In other words, besides the shorter period of 11·11

years in which the solar activity fluctuates from *nil*, or nearly, so to a maximum and back again, it is subject to another and larger period of 56 years (55·55 ?), during which the extent of the former fluctuation is nearly doubled. The maximum of this greater fluctuation may provisionally be placed about the years 1780 and 1836. 2nd. Another conclusion hardly less interesting is, that in adjacent or nearly adjacent 11-year periods of unequal length, a greater degree of activity during the shorter *tends* to compensate in the total number of spots produced, for a less energy in the longer.

These results are in a high degree enigmatical, and up to the present time no clear account of them has been given. Were the spots sufficiently large and numerous to produce any considerable defalcation of light they would place the sun at once in the class of variable stars, which present distinct and marked analogies in respect of their laws of periodicity and sub-periodicity, such as at all events point to a common explanation of the two phenomena. Meanwhile it must be noted that in the planetary revolutions we find no such periods as $11\frac{1}{9}$ and $55\frac{1}{2}$ years, and although both Professors Wolf and Schmidt have bestowed some pains on the inquiry whether the application of equations or terms depending on the heliocentric longitudes of the planets may not eliminate some portion of the observed irregularities in the recurrence of the minima of the 11-year period, it does not yet appear that any dependable result of this kind has been arrived at. Indeed, the data have not sufficient precision, nor does the series of observations embrace a sufficient time to lead us to expect it.

As regards the number of spots in each year and in different months of the same year, however, Dr. Wolf ('Mittheilungen,' No. X.) seems to have satisfied himself from the examination of Schwabe's observations from 1826 to 1848 that sub-periods depending on the revolutions of the *Earth* and of *Venus* do really exist. Thus, he finds a perceptibly greater degree of apparent activity to prevail *annually* on the average of months of September . . . . . January, than in the other months of each year—and again by projecting all the results in a continuous curve he finds in it a series of small undulations succeeding each other at an average interval of 7·65 months, or 0·637 year. Now the periodic time of Venus (225 days) reduced to a fraction of the year is 0·616, a coincidence certainly near enough to warrant some considerable suspicion of a physical connection.

Yet more enigmatical is the connection which has been considered to subsist between the mean annual abundance of solar spots and the extent of mean annual fluctuation observable in the magnetic elements which determine the position of the needle. Dr. Lamont, of Munich, it would appear, was the first who noticed a periodical increase and decrease in the annual amount of variation of the magnetic declination—the period assigned by him being about ten years. In his 'Resultate der Mag. Obs. zu München,' published in 1846, he states the amount of the mean daily variation in declination for the eleven years from 1834 to 1845 inclusive, which exhibit an increase from 8′·25 in 1834 to 12′·90 in 1836, whence a gradual and steady decline to 7′·41 in 1844. And from this (which as we now perceive falls in per-

fectly with the increase and decrease of the spots in that interval, but without reference to them) he drew the conclusion above mentioned. A similar result was announced in 1852 by General Sabine, and extended to all the magnetic elements—connecting the periodicity with that of the spots, but assuming a period of ten years in accordance with M. Schwabe's first conclusion—and to this period of magnetic change General Sabine we believe is still disposed to adhere. Professor Wolf, however, who has instituted the same system of inquiry into all available observations of magnetic declination, finds this element at least (*so far as dependable observations exist*) to vary in so perfect accordance with his law of solar activity that a table of its mean annual amounts as estimated in the manner above stated is convertible by a mere change of scale and the use of a multiplier constant for each magnetic observatory, into a table of mean decimal variations for the same years in each. It will be recollected, however, that the earlier data here are sparingly scattered, and it would be premature to assert the absolute generality of this conclusion in the face of that to which the Astronomer Royal has been led by his recent elaborate discussion of the Greenwich magnetic observations from 1841 to 1857, *viz.*: that from the rapid decrease of dimension in the projected curves for the several years from 1848 to 1857, their forms remaining the same he is led to believe that in this interval "*some great cosmical change has come upon the earth affecting terrestrial magnetism.*" We should not pass quite unnoticed, however, that, granting the correctness of the epoch of maximum (1836) of Dr. Wolf s longer period of 56 years, this precise interval of time would fall upon the most rapid downward sweep of his average curve of maxima during its progress from the maximum of 1836 to that of 1892.

A connection between the periodicity of the spots and the recurrence of great displays of aurora borealis has also been surmised, and was, indeed, suggested as a possibility by Mairan more than a century ago. The recent researches of Professor Fritz, grounded on a diligent assemblage and collection of recorded auroras instituted by Dr. Wolf, the late Professor Olmsted, and others, have placed this connection in a very distinct light, and shown not only that the 11-year period of the spots has its parallel in the annual frequency of auroras, both in respect of number and the epochs of minimum, but also that the long period of 56 years is represented in that phenomenon, and, in fact, agrees better in indicating epochs of extraordinary abundance and paucity than a longer period of 65 years proposed by Olmsted, without reference to the spots. To dilate on the steps of this inquiry would lead us beyond our limits, and we hasten to the consideration of another class of phenomena, to which observations of Mr. Carrington, from 1853 to 1861, recently published with the liberal aid of a grant from the Royal Society, have given a very prominent degree of interest, as affording at length a glimpse—if not of the physical cause in which the spots originate, at least of the working of a mechanism through which that cause may possibly produce its effect.

We have already noticed, that while the results obtained by different observers and computists as to the position of the sun's axis of

rotation derived from the paths of the spots across his disc agree on the whole satisfactorily, no such good accordance is found between the times of rotation so deduced. Galileo concluded from his observations (of course rudely) a synodic period of 28 days; Scheiner, in 1630, of 26 or 27, corresponding to a *sidereal* period of 25½, or thereabouts; Cassini, 25·59; Lalande, 25·42; Laugier, as a mean result, 25·34; Kysæus, 25·09; and Boehm, 25·32; the discordance between which is too great to be considered satisfactory. Observers, moreover, had noticed that, not only different spots gave different results, but that the same spot observed in several successive revolutions gave results greatly at variance with each other. Thus the observations of M. Laugier afforded periods varying from 24·88 to 26·23 days; and Professor Fearnley of Christiania, from observations of a very remarkable spot in 1857, which presented itself three times on the disc, deduced a series of periods from its passages across and reappearances on the disc, of 25·46, 25·67, 25·83, 25·87, and 26·23 days, respectively and successively. Such differences are far too great to have arisen from error of observation, and can only be attributed to proper motion of the spots themselves relative to the body of the sun, arising from their floating in the solar atmosphere, of which their relative change of heliographical situation suffices of itself to indicate the movement. This conclusion was drawn by M. Peters, from an elaborate series of observations made in 1845-6, in which he first clearly pointed out that the period of rotation deduced from such observations is that of the sun's atmosphere, not of its globe, and is affected, for any particular spot, by whatever atmospheric drift, permanent or temporary, may subsist in the region occupied by it. Thus a way was opened by assiduous observations of the spots to a knowledge of the existence and laws (if any) of the solar atmospheric currents. About the same time was put forth by the author of this notice, a surmise, from the law of distribution of the spots in two tropical belts, with an intermediate spotless equatorial zone, that their origin might perhaps be sought in regular solar winds, analogous in their essential features to our trade-winds, and owing their origin to a different rate of *emission of heat* in the equatorial and polar regions, and a consequent difference of temperature in the two regions.* On the occasion of the spot-minimum of 1855-6, Mr. Carrington, who from 1858 downwards had been assiduously and systematically observing them, was led to make a very important remark as to the distribution of the spots *in latitude*. He found that, as the epoch of the minimum drew on, their average heliographical latitude decreased; the higher latitudes beyond 20° N. and S. becoming deserted, while the equatorial zone became comparatively more and more frequented by them; and this went on steadily till the epoch of the minimum was attained. After this a sudden and most decided change took place. The equator was deserted, and on the reappearance of the spots their average latitudes, N. and S., were found to exceed 20°, the intermediate zone being now as remarkable for their relative paucity as it was before for their relative abundance. On

* 'Results of Cape Observations, 1847.'

searching former records, Dr. Wolf ascertained from the observations of Professor Boehm in 1833-4-5-6, including the minimum of 1833-4, that the same phenomenon had then also occurred, the average latitudes of the spots in 1833 having been 9° 9′, while in 1834, the year immediately subsequent to the minimum, it had risen by a similar sudden spring to 25° 0′, after which (as was also the case in Mr. Carrington's observations) it gradually declined to the normal state. Whether this be a general rule, remains to be seen. If so, it cannot but stand in immediate and most important connection with the periodicity itself, as well as with the physical process in which the spots originate. Meanwhile, however, an opportunity was thus afforded of determining the sun's period of rotation by a great many equatorial spots, as well as by those in high latitudes. The results have been computed and synoptically tabulated with consummate skill and diligence by Mr. Carrington, in the extensive and laborious work already cited, and lead to the following general and highly-remarkable conclusion—*viz.* that the period of rotation as deduced from spots in different latitudes increases with the latitude so far as 50° (beyond which no observations are attainable), or, in other words, that the equatorial regions of the photosphere revolve considerably faster than the polar. According to the law of dependence between the rotatory velocity and the corresponding latitude assigned by Mr. Carrington,* the difference amounts to no less than 5·89 days, the sidereal revolution at the equator being 30·86 days, and at the pole (supposing the same law carried on up to the pole) 24·97 days. At 50° hel. lat., the revolution would be completed in 28·36 days.

Let us now consider what is implied in the law so disclosed. This will depend much on the supposition we may make respecting the rotation of the interior globe, of which we are left in complete ignorance. As extreme hypotheses we may suppose its rotation to be performed in the least of the above-named times, or in the greatest; or, as a *mezzo termine*, in the intermediate period last mentioned.

I. On the first hypothesis, the equator and the photosphere above it will be relatively at rest, and we shall have in analogy to the state of things prevalent here on earth, a region of equatorial calm, not much disturbed for some small number of degrees, &c., to the North or South. As the latitude increases, the photosphere, revolving in continually longer and longer time, will lag more and more behind the surface of the globe for the time beneath, the result being of course what we should call an "East † wind," or relative current from East to West, increasing in intensity with the increase of latitude, and attaining, according to Mr. Carrington's formula, a maximum of intensity (estimated by the *linear* amount of momentary retardation) at

* Mr. Carrington's formula for the amount of diurnal rotatory movement in longitude for a spot in latitude l is $865' - 165'$ (sin. $l)^{\frac{3}{2}}$, which is not *very* different from $700' + 165'$ (log. $l)^2$, which, however, he repudiates as representing the observations less closely.

† Great and habitual confusion arises from the use of the words East, West, Easterly, Westerly, as indicating direction. By an East wind, we would be understood to mean a wind blowing *from* the East; by an Easterly current or drift, whether of air or water, one which sets *from* West *towards* the East.

52° 49′ hel. lat.: that is to say, almost exactly at the latitude where the spots cease to afford us any further information. Its velocity estimated as a surface current at this latitude would be 357 miles per hour.

There is a considerable analogy in such a system of movements to our N.E. and S.E. trade-winds. These also are *nil* in intensity on the equator, and increase in strength with the latitude, up to a certain maximum. This, it is true, occurs in a considerably lower latitude than 53°, but in our ignorance of the law of distribution of temperature over the sun's surface, this can hardly be considered a fatal objection, especially when coupled with the very moderate velocity (for such a globe as the sun) assigned as their maximum. To render it applicable, the photosphere (within the maculiferous region) must be assumed to float, and be entirely contained in the *indraft* current (that which sets towards the sun's equator), and this must also be (within that region) the *upper* current, to provide for the carrying back into the circulation and redistribution of its matter (perhaps in a less luminous state) over the general surface, by the lower: constituting possibly the lower envelope which forms the penumbra of a spot; the spot itself, both umbra and penumbra, being a region in which, owing to some cause of disturbance, the movement of the lower current is arrested, and thrown into eddies and ripples. In this view of things, the temperature of the equatorial atmosphere must be supposed generally lower than that of the polar, which is not incompatible with, but on the contrary may be caused by, *a more copious emission of heat* from the former region, which, as Professor Secchi assures us, is really the case.

II. On the second of our two extreme hypotheses, that which makes the globe of the sun revolve in 30ᵈ·86, the conclusion is very obvious. As the solar atmosphere must then in its entirety revolve quicker than the enclosed globe, there must prevail at every point of the surface of the latter a steady and uniform *West wind*, increasing regularly in intensity from *nil* at the poles, up to 880 miles per hour at the equator. As this current must continually tend to accelerate the rotation of the globe by friction, which by the law of reaction must tend to induce a state of relative quiescence, while yet the exterior current is maintained unabated—this can only be by a force *ab extra*, and we have nothing to fall back upon for such a force but the friction of external matter circulating round the sun according to the laws of planetary motion, and that of the zodiacal light (the plane of whose greatest extension according to the best account we have of it, coincides with the sun's equator) is ready at hand. In that case between a rotation in 25 days, that of the photosphere, and 3 hours that of planetary matter revolving freely at 1·10th of the sun's radius above its surface, *i. e.* between a velocity of 4,609 miles per hour in the former, and 1,012,000 in the latter case, every intermediate gradation of velocity must subsist, while between the photosphere and the globe a difference of velocity of only 880 miles per hour exists.

However enormous this velocity of the external matter, and whatever the density we may attribute to it, we have to accept this last-

mentioned acceleration in the (no doubt exceedingly rare) matter of the solar atmosphere at the level of the photosphere, *as the measure of the final result of its impact and friction.* And on the theory of the frictional generation of the sun's heat, it is the amount of *vis viva* so delivered into the sun to which we have to look for the maintenance of its supply of heat. It would be superfluous to adduce arguments, to show the utter inadequacy of the cause to produce the effect. *If this be all,* the origin of the solar heat is as much a mystery as ever.

III. The intermediate hypothesis may be very summarily dismissed. It has not the merits of either extreme, and is in contradiction to both. It supposes a permanent west wind on the equator, and is therefore inconsistent with any Etesian theory (of a system of trades and anti-trades)—and a permanent set of the whole atmosphere, beyond a given latitude, *to the westward,* equally contradictory to the theory of an external drift, the result of planetary circulation.

Between the two extreme hypotheses there would seem to exist a crucial means of discrimination. The first undoubtedly seems to presume an average tendency of the spots towards the sun's equator, while the latter involves no conclusion either to that or the contrary effect. On this point however, observation is not very positive. Professor Peters is of opinion that there *is* such a tendency, while Mr. Carrington seems to think the contrary. His synoptic table (Observation of Solar Spots, p. 220) exhibits an average, though very small preponderance, in favour of a general movement *towards the poles,* on either side of the equator—but the individual differences, to whatever cause attributable are so very much greater, as to destroy all confidence in such a conclusion. From the result of Professor Fearnley's observations on the spot of 1857, whose periods of return went on successively increasing on each reappearance of the spot, it may fairly be concluded that the spot was *receding* from the equator. Unfortunately I have not been able to ascertain whether such was really the case.

Mr. Carrington puts forth a surmise (p. 248) whether some part of the irregularity in the maculiferous activity of the sun may not arise from the action of Jupiter on the zodiacal light. To appretiate the probability of this we have only to consider—1st. That the zodiacal light can hardly extend beyond the orbit of the earth—assuredly not its denser portions. 2nd. That its medial plane is that of the sun's equator, which is inclined 5° or 6° to the orbit of Jupiter, so that it is only when near their common node that any action, even on the infinitely attenuated portion of it which may reach so far, can take place. And 3rd. That whatever be the form of the zodiacal light *in section,* we have no reason to believe it other than circular *in plan.*

Let us suppose, however (and such a supposition has not been deemed inadmissible in attempting to account for the periodical return of meteors), the existence of an elliptic ring of vaporous, nebulous, or small planetary matter, with such a major semiaxis (4·979) as corresponds to a periodic time of each of its particles = 11·11 years; of such eccentricity as to bring its perihelion within the limits of the solar envelopes; and revolving either in the plane of the ecliptic or in some other plane at a more considerable inclination to the sun's

equator. Let it be further assumed (still in analogy with assumptions not regarded as unreasonable in the meteoriferous ring), that the distribution of the circulating matter in it is not uniform—that it has a maximum and minimum of density at nearly, but not quite, opposite points, and no great regularity of gradation between them. It is very conceivable that the matter of such a ring introducing itself with planetary velocity into the upper and rarer regions of the sun's atmosphere, *at an incidence oblique to its regular and uniform equatorial drift*, might create such disturbances as, either acting directly on the photosphere, or intermediately through a series of vortices or irregular movements propagated through the general atmosphere, should break its continuity and give rise to spots, conforming in respect of their abundance and magnitude to the required law of periodic recurrence. If the change of density from the maximum to the minimum were gradual, but from the minimum to the maximum more abrupt, so as to allow the disturbances to subside gradually, and recommence abruptly—the fresh and violent impulse would be delivered first of all on a region remote from the equator (by reason of the obliquity of the ring), and would give rise to a recommencement of the spots in comparatively high latitudes.

If the section of such a ring as we have supposed at its aphelion were *nil*, the period of 11·11 years would be strictly carried out; the maxima and minima would succeed each other with perfect regularity, and the paucity and abundance of the spots in the several phases of the same period would follow a fixed ratio. But if not, the several parts of the ring would not revolve in precisely equal times—the period of 11·11 years would be that of some dominant medial line, or common axis of all the sections in which a considerable majority of its matter was contained—and the want of perfect coincidence of the other revolutions would more or less confuse, without obliterating the law of periodicity, which, supposing the difference to be comprised within narrow limits, might still stand out very prominently. Now it might happen that there were two such medial lines, or more copiously stocked ellipses, each having a maximum and minimum of density, and that their difference of periodic times should be such as to bring round a conjunction of their maxima in 56 or any other considerable number of years: and thus would arise a phenomenon the exact parallel of Dr. Wolf's long period and his series of greater and lesser maxima.

It will, of course, be objected that the resistance of the solar atmosphere would retard and ultimately destroy such a ring. But we must bear in mind the extreme tenuity of this atmosphere in its upper regions, and that our ring need not consist of mere vaporous matter. It might be a collection of exceedingly small planetules, which, however thinly dispersed over an immense space *in aphelio* and in the remoter parts of their orbits, would become crowded together *in perihelio*, acting as it were by a joint *rush* to produce the disturbance, but each individually suffering a resistance infinitesimal compared to its inertia. The comet of 1843 passed within the region we are contemplating, and its motion was not destroyed.

The orbits of our planetules would in fact be, *par excellence*,

cometary; they would surround the sun very closely for nearly half its circumference; and if their common perihelion should occur in or near the longitude which the earth has in December, a preponderance of spots in the autumn and winter months would be far from improbable.

Our ring might lie in the plane of the ecliptic or near it, and so might intersect the orbit of the Earth, or Venus, or Jupiter. Of the influence of such intersection we may conjecture much, but can discern nothing distinctly; and our readers may be disposed to think that we have advanced far enough already into the regions of conjecture.

STEAM NAVIGATION, ITS RISE, PROGRESS, AND PROSPECTS.

By MARTIN SAMUELSON, Member of the Institute of Civil Engineers.

IT seldom occurs to the active minds engaged in the consideration of man's age, and his relations to the lower animals, that, in order to arrive at accurate conclusions upon these subjects, it is necessary, not only to study the traces he has left behind him in the earth's strata, and the history of his recent physical development, but also to direct the attention to the method in which he has executed plans that seem to have been prompted by some superhuman—nay, why need we hesitate to say—Divine agency.

How does it happen that throughout the thousands of years in the historic record, as well as in the ages before the supposed date of his creation, during which we are now taught to believe that man existed in dark ignorance, not the remotest idea appears to have occurred to him of the practicability of rendering the physical forces subservient to his will; and that up to the commencement of the present century, his utmost attainments were unable to rescue him from the power of the elements? For it is only an affair of yesterday that he was bound to go or stay, to lie becalmed or be driven he knew not whither across the boundless main, as it pleased the volition of the tempest.

And again, dismissing for the present the consideration of the marvellous strides which were made in the new locomotive enterprise after it was once fairly started, is it not a matter for reflection, as we look abroad over the nations of the earth, to find perhaps side by side with the Leviathan (for it is more than probable that she may one day be ploughing her way across the Pacific Ocean) the hollowed-out trunk of a tree, the primitive boat, filled with naked savages and propelled by paddles which, with the boat itself, may have been shaped by means of the serrated bone of some predaceous fish?

Who will venture, with such a contrast before his eyes to-day, to assert that man—that is, *reasoning* man—is not a creature of yesterday?

It appears to us to be the Creator's intention, just as He has preserved for us the fossil remains of extinct species of animals, in order

to afford us a retrospective glance over the early history of the globe and its animated freight, to have retained also, fresh and living before our eyes, the illustrations of aboriginal barbarism in the persons of men accompanied by their primitive appliances, so that we may not excuse ourselves, through ignorance of the past, from seeking to afford a worthy example, and to mould the minds of future generations.

These are indeed interesting subjects for the consideration of ethnologists and anthropologists; but unfortunately (or perhaps we should say fortunately for our readers) we are unable to proceed with such inquiries, for we are reminded that we have undertaken, in the space of a few brief pages, to furnish a retrospect of the past history of Steam Navigation, and to indicate, in as many lines, what we believe to be its future prospects. Nor have we, in the performance of this task, to overcome the last-named difficulty alone; that is, of condensing into a few pages the history of what we shall term a scientific art, upon which many volumes, some of them of no mean proportions, have been written. There is still another fence between our readers and ourselves, and that is one in which we shall seek only to break a gap for the purpose of opening a communication with those who are likely to be interested in our brief story. Should the heads of this narrative have the effect, as we trust they may, of whetting their appetites, and of causing them to long for deeper draughts from the sources whence we have drawn, then indeed they must widen the passage for themselves, and effect an entrance into *our* field; for it would be impossible for us to drag all our technicalities through the narrow aperture which enables the practical man of science to hold converse with the popular reader, or the tyro in knowledge.

Steam Navigation has, during the brief period of its existence (for its history extends but over half a century), attained a degree of perfection which may not be excelled for generations to come. It has linked, more closely the tropics and the poles, the old world and the new; and, with the exception, *perhaps*, of the Electric Telegraph, there is no modern invention that has effected more in the cause of civilization than the engine for marine locomotion. Even in its relation to Electric Telegraphy, everyone must admit that it has been the immediate precursor, if not the instigator, of that power; for what was left to man after he had succeeded in holding communication with his fellows thousands of miles away, in the course of a few days, converting him who was a stranger in distant climes into an immediate neighbour—what remained for him, we say, but to contrive the means of bringing this one still nearer, for the purpose of conversing with him as though they abode under the same roof? Was it not over the well-trodden path of the Millers, the Fultons, the Watts, and the Stephensons, that Wheatstone conceived the idea of winging his flight?

Indeed, with the discovery of steam navigation there commenced quite a new era in the history of our race. Many physical and mechanical difficulties had to be overcome before sufficient progress was made in the art to make it the means of extending the commerce of

the world, of nourishing the poor with better food, or of providing fresh comforts and luxuries for the rich; but greatly as we may plume ourselves as Englishmen upon the share we have had in its rapid development, still it behoves us, in the spirit of impartial chroniclers, to award the merit of the first discovery not to one of our own nation, but to an intelligent and enterprising foreigner—a Spaniard.

Perhaps the earliest account we have of a vessel being propelled by steam power is contained in some manuscripts in the archives of Salamanca; these appear to prove that in the year 1543 a naval captain, named Don Blasco de Garray, invented a machine moved by steam, and capable of propelling ships independently of oars or sails. The apparatus referred to was fitted to a vessel of about 200 tons, called 'La Santissima Trinidada,' and an experiment was conducted in Barcelona Roads on the 17th June, 1543, in the presence of the Emperor Charles V., his son, Philip II., and many illustrious persons, which resulted in the ship's attaining a speed of one league per hour; but the apparatus appears to have been condemned, and no further attention was given to it, on account of the apprehension of explosion from the boiler, and the great complexity and expense of the machine; although the Emperor is stated to have reimbursed De Garray for all the expenses he had incurred in making his experiment.

In 1736, Jonathan Hull took out a patent for applying the steam-engine as a motive power to propel ships; and quoting from the description of the invention, we have the following:—"It has been demonstrated that when the air is driven out of a vessel of 30 inches diameter, the atmosphere will press on it to the weight of 4 tons 16 cwt.; and when proper instruments are applied to it, it must drive a vessel with great force." He also described the machinery for working a pair of paddle-wheels, and a drawing was given, representing a tug towing a two-decker against the wind, this tug having a chimney from which smoke issued, and in the after part of the boat was an engine working two paddle-wheels attached to spars abaft each quarter. But the steam engine was at this time in a very imperfect state, so that no practical success was attained, although a vast number of experiments were made by many ingenious men.

It was not until the towering genius of Watt had made the steam-engine the complete and elegant machine that it now is, that steam navigation began to exhibit any signs of success; and we therefore pass over the various experiments (many of them unsuccessful) which were made, until we come to those of William Patrick Miller, who in 1787 took out a patent for paddle-wheels (very similar to those at present used) for propelling vessels; and a Mr. Symington having about this time patented a new application of the steam-engine, was introduced to Mr. Miller; and they between them contrived to make a small steamer, which moved at the rate of five miles per hour; but this was little more than a toy, as the cylinder was only 4 inches diameter. It may be interesting to the reader to know that the engine last referred to may be seen in the South Kensington Museum.

In 1788, John Fitch obtained a patent for the application of steam to navigation in the states of Pennsylvania, New York, New Jersey,

and Delaware; he induced several moneyed men to assist him, and after a considerable outlay, constructed a steam-boat, which, however, only attained a speed of 3 miles an hour. The shareholders were, notwithstanding, induced to make another trial; and a second vessel was completed, which went 8 miles an hour.

Another American, James Ramsey, had also taken out a patent, and in 1788 he came over to England, where he induced a wealthy American merchant to join him in building a steam-boat; but Ramsey died before its completion. The vessel was finished and afloat in 1793, when she made several trips on the Thames, effecting about 4 knots per hour.

In the year 1801, Lord Dundas, a large proprietor in the Forth and Clyde Canal, employed Mr. Symington to conduct a series of experiments on steam-boats, in order that they might be substituted for the horses which were used for drawing the canal boats. These experiments resulted in the construction of the *first practical steam-boat*, named the 'Charlotte Dundas.' The particulars of the trial of this boat are described as follows:—

"Having previously made various experiments, in March, 1802, at Lock No. 20, Lord Dundas, the great patron and steam-boat promoter, along with Archibald Spur, Esq., of Elderslie, and several gentlemen of their acquaintance, being on board the steam-boat, took in tow two loaded vessels, the 'Active' and 'Euphemia' of Grangeworth, Gow and Ephine masters, each upwards of 70 tons burden; and with great ease carried them through the long reach of the Forth and Clyde Canal to Port Dundas, a distance of 19½ miles, in six hours, although during the whole time it blew a very strong breeze right ahead, so much so that no other vessel could move to windward in the canal that day."

This placed beyond a doubt the utility of the steamer in canals and rivers, and ultimately on the seas. In spite, however, of the great success of this experiment, objections were raised by the proprietors of the navigation to the use of steam-boats, fearful lest the banks of the canal would suffer from the wash of the undulation produced by the paddle-wheels. The 'Charlotte Dundas' was therefore laid aside, and, with very few exceptions, no further experiments have been made with steam navigation in canals; where such has been the case, the screw has been resorted to.

In 1806, Robert Fulton, an American engineer, commenced a steam-boat, which was completed in 1807, and destined to run between New York and Albany, a distance of 146 miles, which she accomplished in about 30 hours. The terror and surprise of the people at Albany was very great when they saw this strange ship approaching them, and is thus described by an American journalist:—

"She had the most terrific appearance from other vessels that were navigating the river. The steamer, as many do now in America, used dry pine wood for fuel, which sent forth a column of ignited vapour many feet above the flue; and whenever the fire was stirred, a galaxy of sparks flew off, and in the night had a very beautiful appearance. Notwithstanding the wind and tide were averse to its approach, they

saw with astonishment that it was rapidly coming towards them; and when it came so near that the noise of the machinery and paddles was heard, the crews in some instances shrunk beneath their decks from the terrific sight, and left their vessels to go ashore; while others prostrated themselves and besought Providence to protect them from the approach of the horrible monster which was marching on the tide, and lighting its path by the fire which it vomited."

She was called the 'Clermont,' and was the first steamer which, as well as being a practical success, remunerated her owners.

About this time, a countryman of Fulton's, John Cox Stevens, had completed a steamer; but as Fulton had obtained the exclusive right of navigating the waters of the state of New York, Stevens boldly determined to convey his ship to the Delaware by sea: he was thus the first who took a steam-boat to sea. Fulton had much prejudice to overcome in introducing steam navigation, but the Americans soon became aware of the immense commercial advantage that must result from its adoption, and accordingly steamers multiplied with great rapidity, so that in the year 1821 there were not less than 300 steamers at work in America.

Returning again to England, it was not until the year 1812 that steam navigation was brought into practical use in this country, when Mr. Henry Bell started on the Clyde a small steam-boat, called the 'Comet.' She was only 40 feet long, 10 feet 6 inches beam, and of 3½ horse-power. There was nothing novel in this small boat, and, in fact, Symington's 'Charlotte Dundas,' which has already been referred to, was a far more perfect steamer than either Fulton's 'Clermont' or Bell's 'Comet;' but great merit is due to Bell that he succeeded in establishing steam navigation in this country, just as Fulton had done in America. To Symington, however, is due the honour of having constructed the first practical steam-boat.

From this time the number of steam-boats began to augment with astonishing rapidity, not on the Clyde alone, but on many of the principal rivers of England. The steam navigation of rivers having now become an established fact, enterprise soon determined that steamers should be sent to sea. Accordingly, in 1815, the 'Rob Roy,' a steamer of 90 tons and 30 horse-power commenced running between Glasgow and Belfast, and was therefore the first regular sea-going steamer in England.

In 1816, several wealthy men formed a company for the purpose of establishing a line of steamers between Dublin and Holyhead; they had two built, the 'Britannia' and 'Hibernia,' both of 107 tons and 20 horse-power. In this early stage of steam navigation they accomplished the run with tolerable regularity, but the defects in the form of the ships and the imperfection of the machinery caused them eventually to be placed on one side. The problem of making successful sea-going steamers being now thoroughly solved, they began rapidly to increase their numbers, and steam navigation quickly extended to other countries, France, Russia, and Holland all pressing forward to participate in the grand invention. It would be needless to enumerate

the various steamers which now made their appearance in every part of this country.

The first regular steamer which plied on the Thames was the 'Margery,' of 70 tons and 14 horse-power. She made the trip from London to Gravesend in one day, returning the next; but another steamer, called the 'Thames,' soon eclipsed her performance, making the trip there and back in the same day.

In 1822, a company was formed, with the bold idea of establishing a steam communication with India by what is so well known as the Overland Route. It became necessary that steamers should be placed in the Red Sea to meet those coming from England, and accordingly a vessel called the 'Enterprise' was built and launched by Messrs. Gordon of Deptford, in February, 1825; she was rigged as a three-masted lugger, and was fitted with engines of 120 horse-power, by Messrs. Maudslay. The boiler was of copper, and in one piece, weighing 32 tons; her consumption of fuel was about 12 tons per 24 hours. She sailed from Falmouth deeply laden with coal for the voyage, on the 16th August, 1825, and arrived in Diamond Harbour, Bengal, 7th December, the distance being 13,700 miles; which was therefore accomplished in 113 days, whereof 63 were under steam and 40 under sail, the remaining ten days having been occupied in cleaning her boiler at St. Thomas and in coaling at the Cape. The result of this experiment was very disappointing, both to the public and the shareholders, as they had anticipated that less than 80 days would have sufficed for the voyage. Government, however, bought the ship for 40,000*l.*, so that the enterprising speculator lost but little; she was used in the Burmese war with great success. Although, however, the 'Enterprise' had not realized the expectation of the projectors, we cannot but regard her as a success, for she was in a great measure the pioneer in long steam sea-voyages.

In 1827, Government established a line of steamers between Falmouth and the Mediterranean; these vessels averaged throughout the year 7½ knots per hour. At Bombay, in 1830, a steamer was built of 400 tons burthen and 160 horse-power, named the 'Hugh Lindsay,' with the object of establishing steam communication between Bombay and Suez; and on the 20th March she started from Bombay, and reached Aden (where a coaling station had been provided) on the 7th April, and thence to Suez, where she arrived on the 29th May. This voyage fulfilled its object in showing the practicability of a rapid steam communication with Europe, and eventually led to the establishment of the Peninsular and Oriental Company.

In 1836, a company was incorporated at Bristol with the magnificent project of Transatlantic steam navigation. Hitherto, no steamers of any great magnitude had been constructed, and those which had made long voyages had depended on their sails as much as on their steam power; but this company, which was called the Great Western Steam Navigation Company, felt convinced that to convey passengers and mails with regularity, they must depend on their steam power only. To accomplish this, however, the ship would be compelled to

carry a very large quantity of coal, and must be provided with great engine power; she would therefore have to be constructed of such dimensions as would enable her to comply with these requirements; hence they determined to build a ship of wood, called the 'Great Western.'

She was built at Bristol in the year 1837, by Mr. William Patterson; her principal dimensions being 212 feet by 35 feet beam and 34 feet deep. These dimensions were at that time considered gigantic, and the idea of being able to make a steamer of these proportions (that is to say, of so great a length in comparison with her breadth) to cross the Atlantic with safety was scouted by many scientific men as utterly impracticable; one of the great objections raised being that such a ship must inevitably break her back when poised between two waves, the middle being unsupported. Dr. Lardner was the foremost amongst the scientific men of the day who proved most satisfactorily to "himself" that the 'Great Western' must be an utter failure, both from a scientific point of view and also as a mercantile speculation; and yet Lardner has compiled many really useful works, and has manifested considerable intelligence on most subjects with which he has dealt. It certainly shows us how easily scientific theorists, arguing from assumed data and not from experiment, are led to make the most positive assertions, which prove to be wide of the actual results; at the same time we must not forget that sound practice can only be acquired in conjunction with, or assisted by, sound theory; the latter should, however, always be deduced from careful experiment.

In spite of the forebodings of Dr. Lardner and other wise prophets, the 'Great Western' was built and successfully launched, being at that time regarded as a greater wonder than is the unfortunate 'Great Eastern' at this day.

She was fitted with side lever-engines of 420 horse-power, manufactured by Messrs. Maudslay, Sons, and Field, of London; the cylinders were 74 inches diameter, with a stroke of 7 feet; the paddle-wheels were 28 feet diameter, the paddle-boards being 10 feet long, 2 feet wide, and 20 in number. At length this wonder of steam-ships was ready for sea, and on the 8th April, 1837, she started on her first voyage across the Atlantic, with only 7 passengers on board. The run to New York was accomplished in 15 days 10 hours, which was certainly for that time a very remarkable performance; and towards the end of May she made her appearance in England with 66 passengers, having performed the voyage in 14 days; thereby falsifying the sage predictions of those worthy philosophers who had so confidentially prophesied her incapacity to cross the Atlantic Ocean. She continued to run with the greatest success, weathering the most tremendous gales, and proving herself to be what might well be called, even in these advanced days of steam navigation, a most satisfactory ship. As a specimen of sound shipbuilding, good engineering, and mercantile prosperity, she was an unexceptionable undertaking. She was economical with her coal, burning from 36 to 42 tons per day, or about 4 to 4½lbs. per indicated horse-power per hour, a consumption of fuel quite as economical as that of the average of steamers at the present time,

so that we have not effected much in the economy of fuel within the last twenty-five years.

This admirable steamer was broken up only a few years since in the Thames.

By a strange coincidence, a steamer called the 'Sirius' started on the same day with the 'Great Western,'—the 8th April; she also was designed with the same object as the 'Great Western,' but she occupied 19 days in making the voyage from Cork to New York, notwithstanding that she was aided by her sails; so that to the 'Great Western' is due the glory of having first completed a successful transatlantic voyage, and she crossed the Atlantic no less than 84 times between her first voyage and the year 1844.

The complete success of the 'Great Western' led the directors of the Great Western Steam-Ship Company, under the advice of the late Mr. Brunel, to greatly extend their former efforts, and a steamer of colossal dimensions was projected as being likely to prove a proportionately greater success, both as a ship and as a mercantile speculation. The celebrated steamer 'Great Britain' was the result of this determination. But at this time the use of iron in preference to wood for shipbuilding purposes was strongly advocated by many able men, and several iron steamers had already been most successfully constructed; hence, after careful investigation into the comparative merits of iron and wood, and with the advice of Mr. Brunel, it was resolved that the new ship should be built of iron. Her principal dimensions are—length between perpendiculars, 289 feet; breadth, 51 feet; depth, 32½ feet; tonnage, 3,433 old measurement. The keel of the vessel was laid in July, 1839, and she was launched in the presence of his Royal Highness the late Prince Consort, 19th July, 1843.* At that time she was considered of gigantic proportions, and we cannot but admire the bold enterprise and masterly conception of the projectors. She naturally excited intense curiosity, and was visited by immense numbers of spectators, including shipbuilders, engineers, naval officers, and distinguished savants of every nation. At this time Mr. Smith had most satisfactorily developed the fitness of the screw as a propeller for steam-ships in the elaborate experiments of the 'Archimedes' and H.M.S. 'Rattler.' It was with the latter vessel that an interesting experiment was tried, for the purpose of comparison between the screw and paddle-wheels as propellers. The 'Rattler' was precisely the same form and power as the 'Polyphemus' paddle-steamer. The two ships were tied together, and steamed away as rapidly as they could; the result being that the 'Polyphemus' had to give in to her rival, the 'Rattler.' Mr. Brunel, in consequence, strongly advocated the application of the screw to the 'Great Britain,' and it was finally determined that she should be fitted with one. She was therefore provided with very ponderous machinery of 1,000 horse-power; the engines consist-

* A period of four years. What would become of Steam Navigation, and in fact, of the commerce of this country if shipbuilding had remained stationary in this particular? There are now firms in England who can, *in one year*, execute orders for vessels in the aggregate amounting to six times the tonnage of the 'Great Britain.'

ing of 4 cylinders, 88 inches diameter and 6 feet stroke; on the shaft of the engines a great drum, 18 feet diameter, was fixed, and the screw shaft was also provided with a drum 6 feet diameter, and the motion was communicated from the engine to the screw shaft by means of four chains, so that the screw made three revolutions to one of the engine. She had six masts, with iron rigging, as offering less resistance to a head wind than the ordinary rigging. The mid-ship section of the ship is of a peculiar form, the sides falling in very much, so that at a light draught she would not be nearly so broad at her water-line as at a deeper immersion; but before she left the works it was deemed advisable to put her machinery on board. The effect of this was that she was brought to her bearings at the greatest beam, and having to pass through a lock, it was found that the widest part of the ship came in contact with it, and it was necessary to widen the upper portion of the lock to enable the vessel to pass through into the river. At last she started on her trial trip, and her machinery and propeller gave the greatest satisfaction. She made the voyage across the Atlantic in the most successful manner until she was unfortunately stranded in Dundrum Bay, where she lay a whole winter; but by the unceasing efforts of Captain Claxton and Mr. Bremner, she was at length raised, removed from her perilous situation, and taken to Liverpool, where she was thoroughly repaired. Her machinery having been most seriously injured, it was taken out and replaced by a pair of oscillating geared engines, by Messrs. John Penn and Son, of 500 horse-power, or only half the power with which she was originally provided; but with these new engines she accomplished even a greater speed under steam than she had attained with the old machinery, which was altogether disproportionate to her size. Her rig was also altered, and she is now ship-rigged, and as handsome as any steamer entering the port of Liverpool. She has made some of the fastest voyages to Australia and back on record, and may fairly be deemed one of the most successful and splendid steamers ever built.

The 'Great Western' having led the way, there were soon plenty of followers, and magnificent steamers began to multiply, amongst which we may mention the 'British Queen' and the 'President,' the total loss of which was such a terrible disaster in the early days of transatlantic steam navigation. Then we have the splendid fleet of the West India Mail Company; the Collins' line, with its 'Arctic,' 'Pacific,' 'Baltic,' 'Atlantic,' &c.; the Cunard line, with its 'Acadia,' 'Asia,' 'Arabia,' and the magnificent 'Persia' and 'Scotia.' The 'Persia' constituted another great advance in size and speed. This magnificent steamer was built by Mr. Robert Napier, of Glasgow, and was launched the 3rd July, 1855; her extreme length is 389 feet; breadth 45 feet, and over the paddle-boxes 71 feet 6 inches, and her depth 31 feet 6 inches. She is fitted with side-lever engines of 850 horse-power; cylinders 100½ inches diameter, with a stroke of 10 feet; she has eight boilers, with five furnaces in each; and her paddle-wheels are 38 feet 6 inches diameter, the floats being 10 feet 8 inches by 2 feet, and 28 in number. She carries 1,200 tons of coal, and her displacement at 22 feet draught is 5,400 tons.

The 'Scotia' is a sister-ship, but a little larger.

Then we have the superb fleet of the Peninsular and Oriental Company—the 'Pera,' 'Ceylon,' 'Massilia,' 'Delta,' 'Simla;' and for this Company also was built the magnificent screw-steamer 'Himalaya,' by Messrs. C. J. Mare and Co., in 1853; her extreme length being 372 feet; breadth for tonnage 46 feet 2 inches, and depth of hold 24 feet 9 inches; she is fitted with horizontal-trunk engines, by Messrs. J. Penn and Son; cylinder 84 inches diameter, and 3 feet 6 inches stroke: her propeller is 18 feet diameter, and 28 feet pitch. She was purchased by Government for a transport ship during the Crimean war, and on one occasion she conveyed 418 troops and 372 horses from Liverpool to Constantinople, a distance of 3,620 miles in a little over 14 days, although she partly lay-to from stress of weather between Cape St. Vincent and Gibraltar.

We now arrive at a period in the history of steam navigation to which it is impossible to refer without a passing word of reflection. In the beginning of this article we spoke of the extraordinary enterprises that Man has from time to time undertaken, as it were, by inspiration; and if, in this respect, there be one more marked than any other, illustrating at the same time the active restlessness of his reasoning nature, it is the undertaking we have now to record, namely, the construction of the 'Leviathan,' or, as she is at present called, the 'Great Eastern.'

In days of yore, the "wonders of the world" presented indelible records of Man's superstition, of his artistic taste, and of his prowess in war; and we have surviving to the present time the Sphinx, the ruins of beautiful temples, the Great Wall of China, &c.; all enterprises of the same essential nature. The construction of the 'Leviathan' is, however, not only characteristic of the great attribute of our age, namely, utilitarian enterprise, but it has developed the minds of men in a new direction, and thus led to a greatly-extended application of the physical forces. The origin of the idea which led to the building of the great ship was this:—

All the steamers to which reference has been made, great as they were, could not carry sufficient coal for a very long voyage without deviating so much from the direct route to obtain fresh supplies of fuel at the coaling stations, as to greatly lengthen the voyage; thus in steaming round the Cape to India or Australia they would have to call at St. Vincent, the Cape of Good Hope, and the Mauritius, to obtain coal, which had to be sent out to those places. Hence steamers which have accomplished the voyage to Australia in a very short time have lost immense sums of money through the ruinous price of fuel at these stations, in spite of their having both a full cargo and complement of passengers; and in extra long voyages fast-sailing clippers have altogether beaten the steamers, inasmuch as they have effected the passage to Australia in quite as short time as the fastest steamers.

Brunel therefore proposed that a ship should be built of such dimensions as would enable her to carry sufficient coal for the longest voyage; and as the cost of this coal at home would be about one-third

of the average price paid on the voyage to Australia for ordinary steamers, she would be worked with far greater economy than other boats, besides making the voyage in a much shorter period. It was with this object that the 'Great Eastern' was projected.

This gigantic vessel was constructed by Mr. John Scott Russell, under the superintendence and direction of Mr. Brunel; her principal dimensions being 691 feet extreme length; 680 feet between the perpendiculars; breadth across paddle-boxes, 118 feet; breadth of hull, 83 feet; depth, 58 feet; and her tonnage by the old measurement, 22,500 tons; she has stowage for 6,000 tons of cargo, and her coal-bunkers will hold 12,000 tons. She is built on what is termed the cellular principle, being similar in construction to the tubes of the Menai Bridge, so that she is virtually a double ship, or one vessel placed inside of another, with partitions running fore and aft between her two "skins." She is divided into twelve water-tight compartments, and the weight of iron in the hull is 8,000 tons. She is propelled by a combination of paddle-wheels and screw. The engines for working the paddles consist of four oscillating cylinders 74 inches diameter and 14 feet stroke, each cylinder complete weighing 38 tons; they are of 1,000 nominal, or 3,538 indicated horse-power. The paddle-wheels are 56 feet diameter, and the floats are 13 feet by 3 feet, and 30 in number. The screw-engines consist also of four cylinders 86 inches diameter and 4 feet stroke, and are of 1,600 nominal, or 4,610 indicated horse-power; the screw is 24 feet diameter, and 44 feet pitch. The boilers for this stupendous machinery, are ten in number, each boiler weighing upwards of 50 tons; four of them drive the paddle-engine, and six the screw. She has also powerful auxiliary engines for turning the screw when under sail, and has no less than ten donkey-engines for pumping, and for various other purposes.

She possesses accommodation for 800 first-class passengers, 2,000 second-class, and 1,200 third-class; and her principal saloon is 100 feet long, 36 feet wide, and 13 feet high. The consumption of coal amounts to 12¼ tons per hour, and the greatest speed by paddles and screw separately is as follows:—Paddles alone, 8 knots; screw alone, 9 knots; giving the screw a decided preference over the paddles. The cubic feet in paddle engine-room, including boiler space, is 116,000; and the cubic feet in the screw engine-room, including boiler space, is 112,000; mean draught of water, 23 feet 8½ inches; mean effective diameter of paddles, 48 feet 7¾ inches; mean slip of paddles, 17·4 per cent.; mean slip of screw, 17·9 per cent.; mean consumption of coal per hour, 12¼ tons; mean miles per hour, 14$\frac{1}{11\cdot3}$; coal consumed per indicated horse-power, 3½ lbs.; ditto per nominal horse-power, 11⅛ lbs.; greatest distance run in 24 hours, 360 miles; mean revolution of paddles per minute, 10¾; of screw, 36¾; mean displacement, 19,273½ tons; or, with 5,000 tons of coals on board at 24 feet 10 inches draught, 20,940 tons.

As a specimen of expert workmanship and strength the 'Great Eastern' has never been excelled.

The following particulars of length and beam of some of the

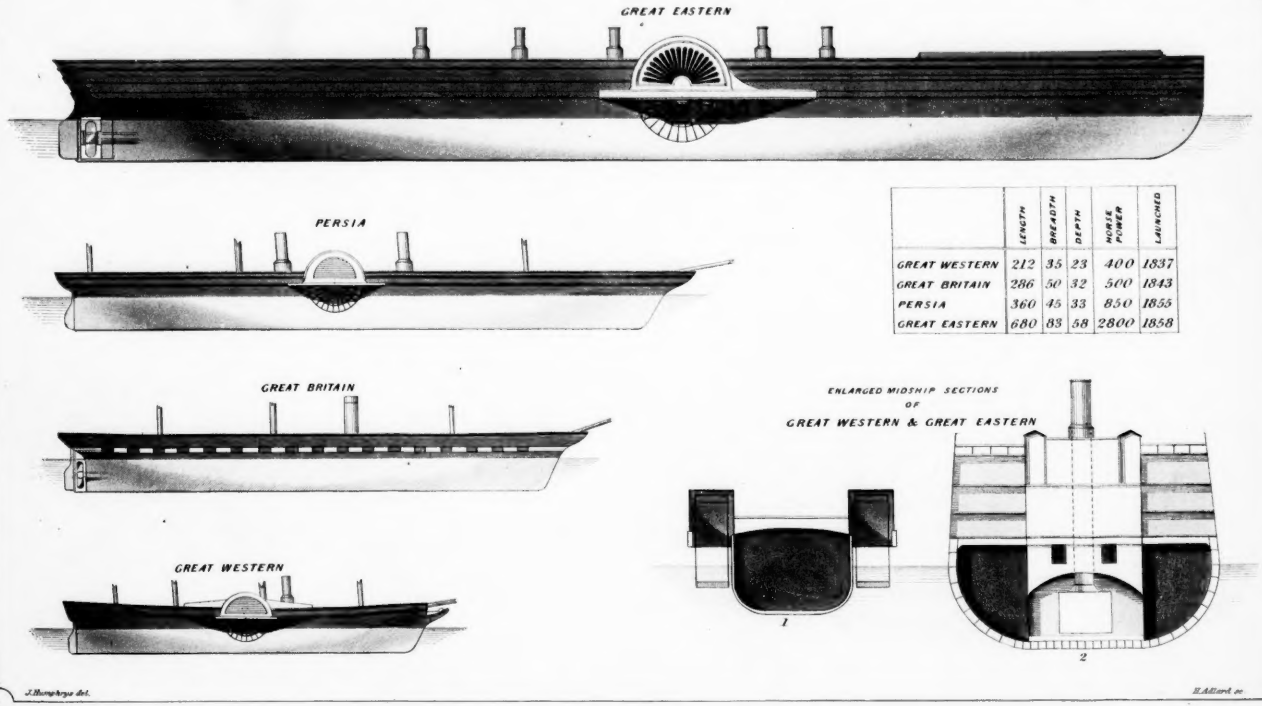
principal transatlantic and war steamers will give a general idea of the size of the monster steamer last alluded to.

Comparative Dimensions of a few of the Largest Steamers.

	Built.		Length.	Breadth.
Great Western . .	1838	First Atlantic steamer . .	236	36
Great Britain . .	1844	First Ocean screw steamer .	322	51
Himalaya	1853	. . . . .	372	46
Persia	1856	. . . . .	390	45
Duke of Wellington .	1855	First-rate line-of-battle ship .	240	60
Warrior	1861	Iron-plated frigate . . .	380	58
Great Eastern . .	1858	. . . . .	680	83

In order, however, more fully to illustrate the great difference in size between the first successful transatlantic steamer, the 'Great Western,' and the last, the 'Great Eastern,' as well as to afford some idea of the intermediate steps in the progress of steam navigation, the accompanying plate will be of some service. It exhibits also the difference in the general construction of the hull of the vessels; the smaller 'midship section representing the usual system of construction, and the larger one showing the cellular method adopted in the 'Great Eastern.'

Being the largest steamer afloat, we have felt ourselves justified in entering rather more fully into the details of the construction of the 'Great Eastern,'—the more so as it is probable that she will remain unrivalled for many years to come. Independently of her size, she is throughout one of the finest specimens of naval architecture and mechanical genius extant, doing credit alike to her constructor and designer. The 'Great Eastern,' in common with many of the works of Mr. Brunel, is rather an illustration of the talent and energy which can be brought to bear upon mechanical science than, so far, a success from a mercantile point of view; in fact, Mr. Brunel has throughout the whole of his life been an example of genius without practical results. We have only to look at the various works executed by his father and himself to exemplify this; the Thames Tunnel to wit, the Great Western Railway works, the Box Tunnel, the Harbro' cutting, and last, though not least, the Great Eastern, a scientific success, but so far a mercantile failure. This vessel is so much in advance of the age and the conveniences which it affords, and the expenses in case of repair from damage or otherwise are necessarily so exorbitant, that few if any speculators can be found to embark a considerable amount of capital in her as an investment. There is no wet or dry dock at present in existence sufficiently large to admit her; consequently, when the most ordinary repairs are necessary, and even when the vessel requires painting, she has to be laid aground, and from the peculiarity of her form, having no keel, (as will be seen from the accompanying sketch,) it is impossible to get to her bottom without excavating the ground from beneath her. The expenses of loading and unloading too, are serious items in the working of so large a ship, and can only be compensated by long voyages; for what may be called



	LENGTH	BREADTH	DEPTH	HORSE POWER	LAUNCHED
GREAT WESTERN	212	35	23	400	1837
GREAT BRITAIN	286	50	32	500	1843
PERSIA	360	45	33	850	1855
GREAT EASTERN	680	83	58	2800	1858

her terminal expenses would thus be only incurred at longer intervals than in short voyages. As we progress, however, in the construction of docks and other necessary naval works, they will no doubt be so enlarged and by degrees be of such a class as to admit a vessel the size of, or even larger than the 'Great Eastern;' for we fully believe that we are not yet at the extreme limit of size: another quarter of a century will, in our opinion, see vessels of even a larger tonnage than the 'Great Eastern' afloat. This will, however, take many years, and in the meantime the precursors of enlarged views have had to pay the penalty of their hardihood, as was the case in a minor degree with reference to the steamer 'Enterprise' before alluded to.

Of the ultimate commercial success of the 'Great Eastern' we entertain no doubt whatever, but this can only be realized by what may be termed single-handed enterprise, and through her employment on a long voyage, such as that to Australia or India. It will be dependent too upon a modification in the propelling power of the vessel, as well as upon the price at which she can now be obtained. In January last this magnificent ship was put up to public auction by the mortgagees, and although a reserve price of only 130,000*l.* was placed upon her, the highest bid was 50,000*l.* Probably before these pages go to press she may have been sold without reserve for a sum under 100,000*l.*;* and it is only when we recollect that she originally cost above three quarters of a million of money, that we are able to realize the terrible sacrifice which has been made by the present proprietors. Much honour and credit is, however, due to those whose enterprise induced them to embark in the speculation in the first instance, and who thereby rendered patent to the world the feasibility of constructing a vessel of dimensions so much greater than any previous attempt in naval architecture.

It will be easy now for those who have witnessed the failure in a mercantile sense to come forward and profit by the experience of the past, and to remedy those defects or errors which rendered the speculation so ruinous in the first instance; and probably the first step which will be taken when the vessel changes hands, will be to remove the paddle engines and alter her rig. For it will be seen from the foregoing statements that although her speed is increased by the application of the paddle and screw engines combined, it is not commensurate with the expense at which such additional speed is acquired. When the paddles alone are employed, a mean speed of 8 knots is obtained; and with screw and paddle combined, 14 knots under the most favourable circumstances; whereas the vessel will make 9 knots per hour with the screw engines alone.

The saving in one important item of expenditure—namely, fuel—would be so considerable, and the change, if it were effected, would so

* Whilst this article is passing through the press, we are apprised that the 'Great Eastern' was "knocked down" for 25,000*l.*, and a new company, of which Mr. Thomas Brassey, jun., is the leading director, advertises that it has purchased the vessel, and the bonds upon her inclusive, for 97,350*l.*; this new company having been the purchasers of her at auction. A dispute has, however, arisen as to who is the rightful owner, another bidder having put in a claim to her.

obviously constitute the difference between a commercial failure and a pecuniary success, that it appears hardly necessary for us to enter into minute details. It is easy to calculate that with her screw alone at work, the 12,000 tons of coals which she carried would nearly suffice for a 70 days' voyage, but the most striking and at the same time familiar mode of exhibiting the enormous advantages which she would thus possess over any existing transatlantic paddle boat, will be to compare her, under her new conditions, with the 'Persia,' showing the relative consumption of fuel and the carrying capacity of each steamer.

With her paddle engines removed, the 'Great Eastern' would carry about 7,400 tons of measurement goods, and 12,000 tons of coal (more cargo and less coal in proportion). She would burn about 200 tons of coal per diem, and steam 9 knots per hour. The 'Persia' carries 1,257 tons of measurement goods, and 1,700 tons of coal, and, burning about 150 tons per day, attains an average speed of 12 knots per hour. Thus, if we were to take into consideration the increased speed attained by the 'Persia' over the 'Great Eastern,' we should have to take the quasi-consumption of the latter, not at 200, but at 260 tons per day.*

Now let us compare the work as it would be performed by the two boats, with the coal required by each, and we shall find that,—

The 'PERSIA,' carrying 1,257 tons of goods, and consuming 150 tons coal per day, burns 270 lbs. of coal per day for every ton of goods carried by her.

Whilst the 'GREAT EASTERN,' carrying 7,400 tons of goods, and consuming 268 tons of coal per day, would only burn 81 lbs. of coal per day for every ton of goods carried.

This comparative statement exhibits in a general manner how great is the advantage of a screw over a paddle steamer for trading purposes, but as far as the 'Great Eastern' is concerned, we do not hesitate to say that with appropriate internal arrangements she could be made to carry at least 10,000 tons of measurement goods; that with the screw alone and a suitable rig, she would, in an average state of the weather, attain a speed of 10 knots an hour; whilst with a good wind she would keep pace with, if not outstrip, the fastest paddle steamer afloat. A comparison of the transatlantic mail paddle boats, supported by a subsidy, with the screw boats in the same service not so endowed, would further confirm the statement of the superior economy of the screw.

Once more, too, we would repeat that, instead of believing, with many, that her designer and builder have exceeded the legitimate dimensions of a manageable steam-vessel, we hold that not a few of

* Throughout this paper we have avoided technical details which might be obscure to the general reader; but we think it right here to say, that in this comparison between the 'Great Eastern,' without paddle engines, and the 'Persia,' we have duly considered the difference between an increase of cargo and the weight of the engines removed; also the bearing of the greater size and weight of the 'Great Eastern,' in relation to her locomotive power; the "lively" nature of cargo, compared with the dead weight of the engines removed; and the antagonistic action between paddle and screw; but we have only given our deductions in general terms.

our readers will live to see steamers of much larger proportions; and most confidently do we predict a brighter future for the noble vessel now lying idle in the river Mersey.

It has been impossible, in the limited space at our disposal, to give even a tolerably perfect sketch of the progress of steam navigation; but in order to afford our readers some idea of the vast mercantile steam navy that has been called into existence through the insatiable demands of commerce, we may mention that there are at present employed upon one great Ocean route alone, namely, from Liverpool and Glasgow to the continent of North America, 100,000 tons of steam shipping, all created, in addition to vessels that have been lost, since the 'Great Western' was launched; and that there is furthermore a large fleet of additional steamers now in course of construction.

But we have thus far spoken only of our mercantile steam navy, and have said nothing concerning the armaments of our country.

It is indeed unnecessary that we should do so. That governments are slow to move, and that ours did not follow in the wake of the merchant service with any great alacrity, is well known to our readers. They are aware also that having once commenced, the Admiralty added year by year to our steam fleet; and we may say without boasting that in both services we have outstripped our neighbours as completely as when wooden walls protected old England.

But we pass over this portion of the subject without regret or apology, quite content to leave its treatment to other and abler pens than ours.

We have endeavoured to render as intelligible as it is possible for one accustomed rather to building, than to writing about steamers, the theme with which we have been called upon to deal; and have only to remark, in conclusion, that *our* industry was not originated for warlike purposes, although it was afterwards thus applied, or we should rather say misapplied; for had the first steam-boat been endowed with life and speech, we are sure that her earliest sentences would not have been those of anger or defiance, but that she would have proclaimed, as did later the Atlantic telegraph, "Glory to God in the highest, on earth peace and good-will towards men."

NOTE.—Much additional and interesting information on the subject of Steam Navigation will be found in 'Steinitz's History of the Ship' (Longmans), and Captain Claxton's Pamphlet on the 'Great Britain.' We have to acknowledge our obligations to John Scott Russell, Esq., to the owners of some of the trans-atlantic steamers, to Henry A. Bright, Esq. (Messrs. Gibbs, Bright, and Co., owners of the 'Great Britain'), and to many other friends, for valuable information supplied to us.

THE FOSSIL SKULL CONTROVERSY.

ON HUMAN CRANIA ALLIED IN ANATOMICAL CHARACTERS TO THE ENGIS AND NEANDERTHAL SKULLS.

By William Turner, M.B., F.R.S.E., Senior Demonstrator of Anatomy in the University of Edinburgh.

Of the various crania which during the last few years have come under the notice of the geologist and anatomist, few, perhaps, have excited so much interest as those fragments of two human skulls which, from the localities where they were found, have been named the Engis and Neanderthal skulls. The lengthened descriptions given of them in the recent works of Sir C. Lyell 'On the Antiquity of Man,' and of Professor Huxley 'On Man's Place in Nature,' and the light which they have been supposed to cast on the solution of the great problem of the antiquity of the human race, have caused a large amount of attention to be directed to them. Not only have the various circumstances connected with their discovery, the geological conditions under which they were found, and their association or non-association with various animal bones, been carefully noted, but their shape, proportions, and general anatomical characters have been minutely studied.

The Engis Cranium.

This skull was discovered by the persevering researches of Dr. Schmerling in the Engis cave, in the province of Liège, in Belgium. It was found with other fragments of human bones, covered by a layer of stalagmite, and along with it were imbedded the bones of various extinct animals, as the mammoth, the woolly rhinoceros, and the cave bear. Dr. Schmerling regarded it as cotemporaneous with those animals, and from independent researches into the geological relations of the locality, the same opinion has been arrived at by Sir C. Lyell

The skull is a fragment, but the vault of the cranium is preserved. It is to all appearance that of an adult male. Mr. Huxley has carefully described and figured it in both the works above referred to, and has come to the following conclusions respecting it. That there is nothing in its character to give any trustworthy clue to the Race to which it might appertain, for though some of its contours and measurements agree well with some Australian skulls, yet others agree equally well with some European crania; that there is no mark of degradation about it; that it is a fair average human skull, which might have belonged to a philosopher, or might have contained the thoughtless brains of a savage.

The skull with which I am going to compare it was sent to the Anatomical Museum of the University of Edinburgh some months back by Mr. Henry Duckworth, F.G.S. It was found by him in the summer of 1861, when on a visit to St. Acheuil, near Amiens. "It lay about six feet from the surface, in a deposit termed by the quarrymen the 'Découvert' bed, which deposit appeared like a narrow vein or

band of marly sand and small flints, dividing, at an angle of say 45°, the vegetable or brick earth on one side from the black flint deposit on the other." As various remains of the Roman and Gallo-Roman age have been found in this locality, it is possible that the skull may be as old as that period, but there is no evidence that it belonged to an earlier time. The skull is a fragment, but possesses almost the same bones as the Engis cranium. It is the skull of an adult, and from its faintly-marked ridges and supra-orbital processes is either a female, or a male whose muscular development was feeble. The bones possess no unusual thickness or density, such as one not unfrequently sees in the crania of savage nations. They are, however, somewhat friable, of a pale yellowish-brown colour, and much deprived of their animal matter. Numerous linear excavations due to the action of the roots of the plants in the soil are on their outer surface.* The different regions of the cranium are well proportioned to each other, and there are no marks of degradation about it. The strong resemblance in external form between this cranium from St. Acheuil and the Engis skull at once struck me, and careful comparative measurements have confirmed my first impressions. The Engis skull is, indeed, somewhat larger, but the proportions between the corresponding parts of the two crania are closely preserved.†

SKULL.	Length.	Frontal Breadth.	Parietal Breadth.	Occipital Breadth.	Longitudinal Arc.	Intermeatoid Arc.	Hor. Circumference.
Engis . .	7·7	4·4	5·4	4·4	13·75	13·	20·7
St. Acheuil .	7·1	4·1	5·1	4·1	12·2	11·8	19·6

The length of the Engis skull is to its breadth as 100 to 70, that of the St. Acheuil cranium as 100 to 71. If my supposition be correct that the latter is a female, the difference in size may, perhaps, be regarded as merely a sexual difference. The St. Acheuil skull is somewhat more convex posteriorly in its upper occipital region; but, as a rule, the contours of the two crania so closely resemble each other, that one might almost look upon the one from St. Acheuil as a reduced copy of the Engis skull.‡

* The interpretation of this appearance was made for me by my friend, Professor Rolleston, of Oxford; and since my attention was directed to it, I have not unfrequently noted a corresponding appearance in bones which have been buried at no great distance from the surface.

† The measurements of the Engis skull have been taken from a cast supplied by Mr. Gregory, of Golden Square, London.

‡ A minor structural difference consists in the presence of a small triquetral or inter-parietal bone in the St. Acheuil cranium; but such a bone, although at one time supposed to possess, is now known to have no especial value as an index of race character. I have, for example, seen it in two Australian crania, in a Malay, a Hindoo, a North American Indian, a Chilian Indian, a Ceylonese, a Scotch, and a French cranium. It can no longer be regarded as a distinctive peculiarity of the Peruvian skull.

A question of much interest at once suggests itself by this comparison. Are we to regard the occupant of the Belgian cavern as of the same race as the dweller on the banks of the Somme? The geographical distance between the two localities is not great, but the geological distance as regards time between the cotemporary of the mammoth and woolly rhinoceros and the inhabitant of the North of France at a period not more remote than the Gallo-Roman age is, as all present evidence indicates, indeed enormous. The answer to the above question, then, will doubtless be regulated by the opinion which may be entertained of the value of cranial characters, as an element in ethnical comparison. Many ethnologists of eminence consider, and with much reason, the form of the skull as one of the most important tests to be employed in determining the affinities of races, for the crania of individuals of the same race possess a strong general resemblance throughout long periods of time. But whatever opinion may be formed of the identity or non-identity as regards race of the two individuals to whom these crania belonged, there can, I think, be no doubt that, as this skull from St. Acheuil proves, the cranial conformation, and presumably the cerebral conformation also, of the geologically ancient Belgian was in no respect inferior to this inhabitant of France during a period in its history not more distant than the Gallo-Roman time.

The Neanderthal Skull.

The circumstances connected with the discovery of this cranium have been so well detailed by Dr. Fuhlrott, Professor Schaaffhausen, and Sir C. Lyell, and its anatomical characters have been so carefully described and figured by Professor Schaaffhausen, Mr. Busk, and Mr. Huxley, that it is needless for me to enter into any detailed description of them, more especially since Professor King has already placed many of the most important facts connected with it before the readers of this Journal in the number for January. My object will be sufficiently carried out if I especially discuss those features in its structure which either are, or are supposed to be, its peculiar characteristics, and which are considered to distinguish it from all other known human crania.

The skull, when looked at even by one not skilled in human anatomy, is seen to possess remarkable features. The flattened vertex, the low retreating forehead and strongly projecting supra-orbital ridges, at once attract attention, and show that it is an exceptional form of human cranium. To these more obvious characters Mr. Huxley has added yet another, in the shape of the occipital region, which he looks upon as even more striking to the anatomical eye.

The consideration of these peculiarities, together with some others of minor importance, has led Professor King to look upon the being to whom this cranium belonged as specifically, nay more, as generically, distinct from man. But in coming to this conclusion, that observer appears to me to have estimated far too lightly the amount of variation to which the human body is subject, in the structure and arrangement of its constituent parts. I allude not merely to diverg-

ences in the conformation of corresponding parts of the bodies of men of different races, but of individuals of the same race; variations which, though they may be great enough to constitute large and important individual differences, are still not sufficient to warrant our assuming the absence of those characters which are especially and distinctively human. I refer not only to those variations in the form of the features, the colour of the skin, and the nature of the hair, which are discernible on an external examination of the body, but to those deeper or internal differences affecting the origin and distribution of the blood-vessels, the extent of attachment of the muscles, the non-formation in some cases of muscles usually present, and in other cases the development of new muscles. Similarly, the bones themselves may exhibit great variations in the size of their ridges and processes; and in some individuals processes may even occur which do not generally enter into the formation of the human skeleton.* All these afford illustrations of such a great amount of variability as to cause the careful human anatomist to hesitate, if an unusual structure or arrangement in a part evidently human were shown him, before he ventured to pronounce such structure or arrangement to be an indication that the being in whom it occurred was either a distinct species of man, or a form transitional between man and the lower animals.

The Neanderthal skull unquestionably possesses a very remarkable shape, one which sufficiently distinguishes it from other known crania. But we must inquire whether its anatomical characters are altogether exceptional. Is it not possible, in carefully examining an extensive collection of skulls, such as are presented to the anatomist in a large museum or dissecting-room, to find crania closely allied to it in some of those features which are regarded as most distinctive? I have, during the past year, directed much attention to this matter, and have examined numerous crania, both of savage and European nations. The points in the Neanderthal skull which I have most closely compared with other crania, have been—1st, the projection of the supra-orbital ridges and glabella; 2nd, the receding forehead; 3rd, the shape of the occipital region.

The supra-orbital ridges in the Neanderthal skull are characterized not only by their great projection forward, but by their rounded massive form. They extend outwards as far as the external orbital processes, and they run into each other across the middle line at the prominent glabella. Their extent and projection, as is clearly shown in the figure (from a photograph by Dr. Fuhlrott) in Mr. Huxley's work, are due to the excessive development of the frontal sinuses.†

* It may be sufficient to mention here the occasional development on the occipital bone of an additional process called paramastoid, and of a process, the supra-condyloid, springing from the humerus a short distance above the inner condyle. An elaborate description of all the different forms which the latter process presents in Man and a comparison of their arrangement in certain of the Mammalia, as in many Quadrumana, Carnivora, Marsupialia, &c., is given by Gruber, in the 'Mém. de l'Acad. Imp. de St. Pétersbourg,' vol. viii. 1859.

† These sinuses are cavities in the frontal bone due to a want of parallelism between the two plates, of which the bone is constructed. They contain air, and communicate with the nose.

In attempting, however, to form a correct estimate of this projection, it is necessary to bear in mind that the absence of the bones of the face, more especially of the nasal, malar, and upper jaw bones, tends to give a more marked character to it than would probably have been the case had they been present.

Professor Schaaffhausen, in his remarks on this skull, states that in the principal European museums there are no crania which can be compared with it in the amount of this supra-orbital projection; but he refers to various craniological memoirs, in which cases have been recorded of a considerable, though not so great a projection in this region, more particularly in the skulls of ancient and modern barbarous races. Mr. Huxley also, in his critical account of this cranium, alludes to the supra-orbital projection in Australian skulls, though this is not unfrequently due to a solid bony growth, the frontal sinuses being undeveloped. Mr. Busk has also figured the cranium of a red Indian,* and a skull from Borreby, in Denmark, stated to be of the Stone period, in which these ridges project considerably. In the Ethnological collection in the Anatomical Museum of the University of Edinburgh, are also several crania, in which they constitute a striking feature. Some of the New Zealand and Tasmania crania, for example, are cases in point. But this character is by no means confined, as it appears to have been far too generally believed, either to the crania of modern savage races, or to those former denizens of these islands and of continental Europe, the men of the Stone period, of the age of Iron or of Bronze. It is a character which occasionally crops out, as it were, not only in the men, but the women even, of the British Islands at the present day, and at times attains a prominence which, though not quite equalling, yet is but little removed from that in the Neanderthal skull. I have now† before me three modern British crania, and the cast of a fourth (Fig 1) in the Museum of the College of Surgeons of Edinburgh (No. 34), in which it may be studied. In the whole of these skulls, the prominence of the glabella and supra-orbital ridges is most strikingly marked, especially in the extent to which they project forward, though none of them exhibit so massive a form at the external orbital processes as the Neanderthal skull. In two of the crania more particularly (one of which is that of an old woman, Fig 2), there is a deep depression at the root of the nose, such as to all appearance the Neanderthal skull possessed when in its perfect state.

The low retreating forehead is a character which presents much variety in human crania In the one from the Neander valley it is considerable; but as Mr. Huxley has remarked, the supra-orbital projection causes the forehead to appear still lower and more retreating than it really is. But what the true slope of the forehead may have been, there is now some difficulty in accurately determining, on account of the fragmentary nature of the skull, rendering it difficult to say what was the true position of the head. The influence which a change in the position of the head exercises on the slope of the forehead, either in adding to or sub-

* 'Nat. Hist. Review,' vol. i. pl. v.

† The figures refer to the accompanying plate.

tracting from it, is illustrated by the different appearance it presents in the figures of this cranium given by Sir C. Lyell and Mr. Huxley. I have now before me a modern British skull which closely approaches it, nay, is rather more flattened in the frontal region on account of the very faintly marked condition of the frontal eminences. I may refer here also to a fragment of a skull, perhaps that of an old monk, in the collection of Christ Church, Oxford (shown me by Professor Rolleston), and to the cast of the cranium of Archbishop Dunbar (obiit 1547), in the Museum of the Scottish Society of Antiquaries, in both of which there is a remarkably flattened and retreating forehead.

Professor King lays great stress upon the coexistence of the projecting supra-orbital ridges and retreating forehead in the Neanderthal skull; more especially with regard to the part of the frontal bone, which is intersected by a line drawn at right angles to the glabello-occipital line through the infero-anterior angles of the two outer orbital processes. I cannot but think that if Professor King, instead of selecting for his comparison such a recent human skull as the one he figures in Plate 2, Fig. 5,* had taken a human skull presenting in combination a retreating forehead and projecting ridges (such as represented in Fig. 1), he would have found that no great difference existed between it and the Neanderthal skull in the amount of frontal bone cut off by such a line.

I have already stated that Professor Huxley attaches much importance to the shape of the Neanderthal skull in its occipital region. He describes the squamous part of the occipital bone as sloping obliquely upward and forward from the protuberance and superior curved line, so that when the glabello-occipital line is made horizontal, the occipital protuberance occupies the extreme posterior end of the skull, and the lambdoidal suture is situated well on the upper surface of the cranium: as a result of which the posterior lobe of the brain would have been flattened and diminished.

But if this mode of description be adopted, it must be borne in mind that the upward and forward slope is not that of a plane surface. For the squamous plate of the bone possesses a curved surface with the convexity projecting backwards and upwards, though this convexity is undoubtedly much smaller than the greater majority of well-formed crania exhibit. Then again I find, from measurements of the cast of this skull, that the greatest antero-posterior diameter is not included in a line drawn between the glabella and occipital protuberance, but in a line drawn from the glabella to a point in the squamous part of the occiput, about half-an-inch above the protuberance; though whether this point may in this individual have been the most projecting part of the head posteriorly, it is impossible to say, on account of the difficulty of placing this fragment of a skull in its natural position.

But to follow out the method which we have hitherto pursued in this investigation, let us now, by a comparison of this part of the Neanderthal skull with the corresponding region in other human

* Jan. No. 'Quarterly Journal of Science.'

crania, see what value is to be attached to its configuration as an especial character. Messrs. Busk and Huxley have already shown, that in the Danish Borreby skull, and in some Australian crania, the occipital region presents a form closely allied to the Neanderthal skull itself. Additional evidence of this correspondence is supplied by the Australian and Tasmanian crania in the Edinburgh University Anatomical Museum, in one of the former of which the squamous plate is nearly flat, and forms almost a right angle with the surface of the bone below the curved line. But it is not with these savage races only that this comparison can be made. An examination of a considerable number of modern British crania has shown me that a large amount of variation occurs in them in the form of this region, and in the extent of the posterior convexity of the squamous part of the occipital bone. And it would be quite possible to arrange, from materials to which I have access, a series of modern British skulls, in which this variation may be traced from a well-marked posterior occipital bulging to a configuration of the upper occipital region, closely approaching the form of the Neanderthal skull. In the skull-cap represented in Fig. 3, the diminished occipital convexity is almost equal to that of the last-named cranium.*

Professor Schaaffhausen regards the unusual development of the frontal sinuses, supra-orbital ridges, and glabella, as unquestionably typical race-characters, and not as an individual or pathological deformity. To accept such a view, however, it would be necessary to show that a great projection in the supra-orbital region possesses a definite ethnical value. But this, I would submit, is an inconstant feature, for great variations in the size of these ridges are exhibited by the crania of barbarous races, both ancient and modern, in which such projections have been seen. The series of New Zealand, Australian, and Negro crania, in the Ethnological Collection in the Edinburgh University Anatomical Museum, exhibits considerable diversities in this respect. Again, in the beautifully illustrated 'Crania Britannica' of Messrs. Davies and Thurnham, whilst some of the ancient British crania depicted present a considerable projection above the orbits, in others, again, it is but slightly marked.† And as we all know that no great prominence occurs as a rule in the modern British skull, yet, as the specimens already alluded to (p. 254) prove, an amount of projection may occasionally occur not much inferior to that in the Neanderthal skull.

To attempt, then, to found, as Schaaffhausen has done, a typical race-character on so variable a feature, or to build a chief argument in favour of the distinct specific, nay even generic, character of a skull, as Professor King has done, on a solitary cranium in which such largely-developed supra-orbital ridges occur, does not appear to me to be warranted by the facts at our disposal. Mere massiveness—the

* In the University Anatomical Museum is the skull (B. 5) of a modern patriotic Greek, picked up on the plain between Athens and the Piræus, in which this configuration of the occipital region is most strikingly marked.

† Compare, for example, the Ballidon Moor, Uley, and Kennet crania with those from Middleton Moor, Long Lowe, and Littleton Drew.

possession of greater bulk in this region in an individual skull—is not in itself a feature on which to base any specific distinction. As well might we attempt to draw specific characters from a greater or less development of the mastoid processes. To give anything like value to such a character, it ought to be shown to be possessed by the majority at least of the skulls of a given race Keeping in view, then, the amount of variation which this projection admits of in the crania of known races, and in the absence of any skulls cotemporaneous with the one from the Neanderthal with which to compare it, we should hesitate before expressing an opinion that it is an ethnical rather than an individual character.

Amongst the various speculations which have been hazarded, as to the nature and mental capabilities of the man to whom this singular skull appertained, there is one expressed in the inquiry, "But may he not have been an idiot?" In the absence of any definite information, it is alike impossible to prove either that he was an idiot or a sane person. I have, however, compared the skull with the crania of three idiots, and find not only considerable diversities between its form and theirs, but in the form which the idiot cranium itself may present. In one of the idiot's skulls the forehead is low and retreating, and the supra-orbital ridges are large, but the external measurements and internal capacity are so small as to place it amongst the microcephali. Now the Neanderthal skull cannot be regarded as microcephalic, either in its external measurement or internal capacity. It possesses an extreme length of 8 inches when measured from the glabella to the most projecting point of the occiput, and of 7·2 when the measurement is taken between the frontal eminences and the corresponding occipital eminences, which latter diameter is of greater value than the former as an index of cranial capacity, because it eliminates the supra-orbital projection and frontal sinuses. Its greatest breadth is 5·9 inches. Its present capacity is 63 cubic inches: but its capacity in the original condition is estimated by Mr. Huxley at 75 cubic inches, which is the average capacity given by Morton for Polynesian and Hottentot skulls.

Amongst modern European crania, the average cranial capacity is considerably higher than this. Professor Welcker, of Halle,* from careful measurements of 30 normal, male, adult German crania, has placed the mean capacity at 88·4 cubic inches But whilst the maximum of these crania rose as high as 109 cubic inches, the minimum sank as low as 74·4 cubic inches, a capacity scarcely so great as the estimate made of the Neanderthal skull; and the capacity of two others was only 78 and 78·6 cubic inches. Again, Professor Huschke,† from the measurements of 21 male German crania, has found their average capacity to be 88·17 cubic inches; but the smallest of these skulls was no more than 73·1 cubic inches, which is nearly two cubic inches smaller than the Neanderthal skull. Thus though the estimated capacity of this cranium is less than the

* 'Untersuchungen ueber Wachsthum und Bau des Menschl. Schaedels,' 1862, p. 35.

† Schaedel, Hirn, und Seele, 1854, p. 47.

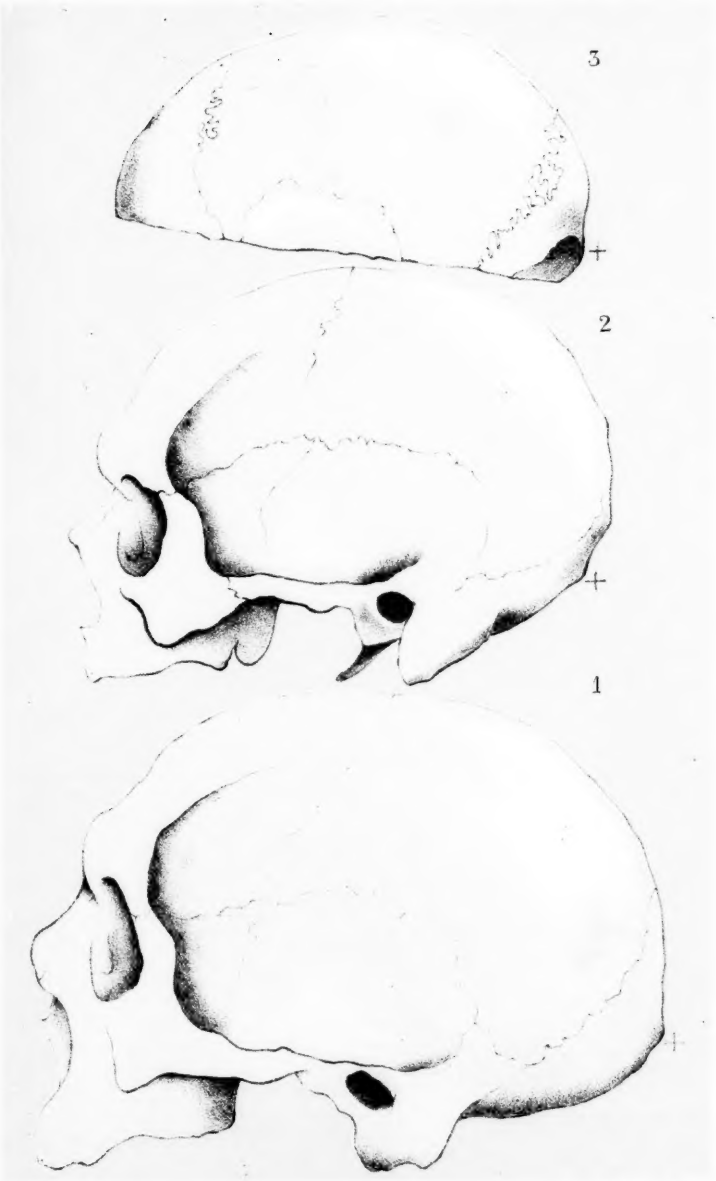
European mean, yet modern male German crania have been measured, which closely approach, and even sink below it. The possession of strong supra-orbital ridges, a low retreating forehead, and a diminished occipital convexity, is not therefore necessarily incompatible with an amount of brain space larger than that yielded by some modern European crania (which such experienced craniologists as Huschke and Welcker looked upon as normal), if the space lost in the frontal and occipital regions is compensated for by increased growth in another direction. And in the Neanderthal skull this compensation appears to have been provided in the parietal region, which is nearly three-tenths of an inch wider than that given by Mr. Busk as the mean breadth of the European skull.* But the skull, No. 34, Edinburgh College of Surgeons' Museum (Fig. 1), yields us still more striking testimony of the occasional co-existence even of enormous cranial capacity with projecting supra-orbital ridges, a low forehead, and diminished occipital convexity. Its capacity is 117 cubic inches, which is three cubic inches greater than that of the most capacious skull I can find recorded.† And like the Neanderthal, it has its greatest breadth close to the squamous suture, and not at the parietal eminences. The cast of the skull of King Robert the Bruce also, copies of which may be found in many museums, shows that that valiant and sagacious monarch had, along with a retreating forehead, a large and capacious cranium.

From the comparison which has thus been instituted, I have no hesitation in saying that, although we may not be able to produce another skull possessing a combination of all those characters which are regarded as so distinctive of the Neanderthal skull, yet the examination of an extensive series of crania will show us that these characters are closely paralleled, not only in the crania of many savage races now existing, but even in those of modern European nations.

How cautious, therefore, ought we to be in generalizing either as to the pithecoid affinities or psychical endowments of the man to whom it appertained. It is as yet but an isolated specimen; of its history prior to the day of its discovery, we are altogether ignorant; its geological age even is quite uncertain. In coming to any conclusion, therefore, we have no facts to guide us, save those which are furnished by an examination of its structural characters. And whatever marks of degradation these may exhibit, yet they are closely paralleled in the crania of some of the men, and women too, now living and moving in our midst.

* 'Med. Times and Gazette,' April 12, 1862. Mr. Busk places the mean breadth of European crania at 5·65.

† The capacity of the largest cranium measured by Welcker was 114 cubic inches; that of the largest measured by Huschke, 109·75 cubic inches.



XUM

ON THE APPLICATION OF THE PRINCIPLE OF "CONSERVATION OF FORCE" TO PHYSIOLOGY.

Part II. (conclusion): *The Relations of Light and Heat to the Vital Forces of Animals.*

By William B. Carpenter, M.D., F.R.S., F.L.S., F.G.S.

Those of our readers who accompanied us through the first part of our inquiry are aware that it was our object to show, that as Force is never *lost* in the Inorganic World, so Force is never *created* in the Organic; but that those various operations of Vegetable life which are sometimes vaguely attributed to the agency of an occult "Vital Principle," and are referred by more exact thinkers to certain Vital Forces inherent in the organism of the Plant, are really sustained by Solar Light and Heat. These, we have argued, supply to each germ the *whole power* by which it builds itself up, at the expense of the materials it draws from the Inorganic Universe, into the complete organism; while the mode in which that power is exerted (*generally* as Vital Force, *specially* as the determining cause of the form peculiar to each type) depends upon the 'germinal capacity' or directive agency inherent in each particular germ. The *first* stage in this constructive operation consists in the production of certain Organic Compounds of a purely Chemical nature—such as gum, starch, sugar, chlorophyll, oil, and albumen—at the expense of the oxygen, hydrogen, carbon, and nitrogen, derived from the Water, Carbonic Acid, and Ammonia of the atmosphere; whilst the *second* consists in the further elevation of a portion of these organic compounds to the rank of Organized Tissue possessing attributes distinctively Vital. Of the whole amount of Organic Compounds generated by the Plant, it is but a comparatively small part (*a*) that undergoes this *progressive* metamorphosis into living tissue. Another small proportion (*b*) undergoes a *retrograde* metamorphosis, by which the original binary components are reproduced; and in this descent of Organic Compounds to the lower plane, the power consumed in their elevation is given forth in the form of Heat and Organizing Force (as is specially seen in Germination), which help to raise the portion *a* to a higher level. But by far the larger part (*c*) of the Organic Compounds generated by Plants remains stored up in their fabric, without undergoing any further elevation; and it is at the expense of these, rather than of the actual tissues of Plants, that the life of Animals is sustained.

When, instead of yielding up any portion of its substance for the sustenance of Animals, the entire Vegetable organism undergoes retrograde metamorphosis, it not only gives back to the Inorganic World the binary compounds from which it derived its own constituents, but in the descent of the several components of its fabric to that simple condition—whether by ordinary combustion (as in the burning of Coal) or by slow decay—it gives out the equivalents of the Light and Heat by which they were elevated in the first instance.

In applying these views to the interpretation of the phenomena of

Animal life, we find ourselves, at the commencement of our inquiry, on a higher platform (so to speak) than that from which we had to ascend in watching the constructive processes of the Plant. For, whilst the Plant had first to prepare the *pabulum* for its developmental operations, the Animal has this already provided for it, not only at the earliest phase of its development, but during the whole period of its existence; and all its manifestations of Vital activity are dependent upon a constant and adequate supply of the same *pabulum*. The first of these manifestations is, as in the Plant, the building-up of the organism by the appropriation of material supplied from external sources under the directive agency of the germ. The ovum of the Animal, like the seed of the Plant, contains a store of appropriate nutriment previously elaborated by the parent; and this store suffices for the development of the embryo, up to the period at which it can obtain and digest alimentary materials for itself. That period occurs, in the different tribes of animals, at very dissimilar stages of the entire developmental process. In many of the lower classes, the embryo comes forth from the egg, and commences its independent existence, in a condition which, as compared with the adult form, would be as if a Human embryo were to be thrown upon the world to obtain its own subsistence only a few weeks after conception; and its whole subsequent growth and development takes place at the expense of the nutriment which it ingests for itself. We have examples of this in the class of Insects, many of which come forth from the egg in the state of extremely simple and minute worms, having scarcely any power of movement, but an extraordinary voracity. The eggs having been deposited in situations fitted to afford an ample supply of appropriate nutriment (those of the Flesh-fly, for example, being laid in carcases, and those of the Cabbage-Butterfly upon a cabbage-leaf), each larva on its emersion is as well provided with alimentary material as if it had been furnished with a large supplemental yolk of its own; and by availing itself of this, it speedily grows to many hundred or even many thousand times its original size, without making any considerable advance in development. But having thus laid up in its tissues a large additional store of material, it passes into a state which, so far as the external manifestations of life are concerned, is one of torpor, but which is really one of great developmental activity: for it is during the *pupa* state that those new parts are evolved, which are characteristic of the perfect Insect, and of which scarcely a trace was discoverable in the larva; so that the assumption of this state may be likened in many respects to a re-entrance of the larva into the ovum. On its termination, the Imago or perfect Insect comes forth complete in all its parts, and soon manifests the locomotive and sensorial powers by which it is specially distinguished, and of which the extraordinary predominance seems to justify our regarding Insects as the types of purely *Animal* life. There are some Insects whose Imago-life has but a very short duration, the performance of the generative act being apparently the only object of this state of their existence: and such for the most part take no food whatever after their final emersion, their vital activity being maintained, for the short period it endures, by the material

assimilated during their larva state.* But those whose period of activity is prolonged, and upon whose energy there are extraordinary demands, are scarcely less voracious in their imago than in their larva-condition; the food they consume not being applied to the *increase* of their bodies, which grow very little after the assumption of the imago-state, but chiefly to their *maintenance;* no inconsiderable portion of it, however, being appropriated in the female to the production of ova, the entire mass of which deposited by a single individual is sometimes enormous. That the performance of the generative act involves not merely a consumption of material, but a special expenditure of force, appears from a fact to be presently stated, corresponding to that already noticed in regard to Plants.

Now if we look for the source of the various forms of Vital force,—which may be distinguished as constructive, sensori-motor, and generative,—that are manifested in the different stages of the life of an Insect, we find them to lie, on the one hand, in the Heat with which the organism is supplied from external sources, and, on the other, in the Food provided for it. The agency of Heat, as the moving power of the *constructive* operations, is even more distinctly shown in the development of the larva within the egg, and in the development of the imago within its pupa-case, than it is in the germinating seed; the rate of each of these processes being strictly regulated by the temperature to which the organism is subjected. Thus ova which are ordinarily not hatched until the leaves suitable for the food of their larvæ have been put forth, may be made, by artificial heat, to produce a brood in the winter; whilst on the other hand, if they be kept at a low temperature, their hatching may be retarded almost indefinitely without the destruction of their vitality. The same is true of the pupa-state; and it is remarkable that during the latter part of that state, in which the developmental process goes on with extraordinary rapidity, there is in certain Insects a special provision for an elevation of the temperature of the embryo by a process resembling incubation. Whether, in addition to the heat imparted from without, there is any addition of force developed within (as in the germinating seed) by the return of a part of the organic constituents of the food to the condition of binary compounds, cannot at present be stated with confidence: the probability is, however, that such a retrograde metamorphosis does take place, adequate evidence of its occurrence during the incubation of the Bird's egg being afforded by the liberation of carbonic acid, which is there found to be an essential condition of the developmental process.—During the larva-state there is very little power of maintaining an independent temperature, so that the sustenance of Vital Activity is still mainly due to the heat supplied from without. But in the active state of the perfect Insect there is a *production of heat*

* It is not a little curious that in the tribe of *Rotifera*, or Wheel-animalcules, all the males yet discovered are entirely destitute of digestive apparatus, and are thus incapable of taking any food whatever; so that not only the whole of their development within the egg, but the whole of their active life after their emersion from it, is carried on at the expense of the store of yolk provided by the parent.

quite comparable to that of warm-blooded animals; and this is effected by the retrograde metamorphosis of certain organic constituents of the food, of which we find the expression in the exhalation of carbonic acid and water. Thus the food of Animals becomes an internal source of heat, which may render them independent of external temperature.—Further, a like retrograde metamorphosis of certain constituents of the food is the source of that *sensori-motor power* which is the peculiar characteristic of the Animal organism; for on the one hand the demand for food, on the other the amount of metamorphosis indicated by the quantity of carbonic acid exhaled, bear a very close relation to the quantity of that power which is put forth. This relation is peculiarly manifest in Insects, since their conditions of activity and repose present a greater contrast in their respective rates of metamorphosis, than do those of any other animals.—Of the exercise of *generative* force we have no similar measure; but that it is only a special modification of ordinary vital activity appears from this circumstance, that the life of those Insects which ordinarily die very soon after sexual congress and the deposition of the ova, may be considerably prolonged if the sexes be kept apart so that congress cannot take place. Moreover, it has been shown by recent inquiries into the Agamic reproduction of Insects and other animals, that the process of Generation differs far less from those Reproductive acts which must be referred to the category of the ordinary Nutritive processes, than had been previously supposed.

Thus, then, we find that in the Animal organism the demand for food has reference not merely to its use as a *material* for the construction of the fabric; food serves also as a generator of *force;* and this force may be of various kinds,—Heat and Motor-power being the principal but by no means the only modes under which it manifests itself. We shall now inquire what there is peculiar in the sources of the Vital Force which animates the organisms of the higher animals at different stages of Life.

That the developmental force which occasions the evolution of the germ in the higher Vertebrata is really supplied by the Heat to which the ovum is subjected, may be regarded as a fact established beyond all question. In Frogs and other Amphibia, which have no special means of imparting a high temperature to their eggs, the rate of development (which in the early stages can be readily determined with great exactness) is entirely governed by the degree of warmth to which the ovum is subjected. But in Serpents there is a peculiar provision for supplying heat; the female performing a kind of incubation upon her eggs, and generating in her own body a temperature much above that of the surrounding air.* In Birds, the developmental process can only be maintained by the steady application of external warmth, and this to a degree much higher than that

* In the Viper the eggs are usually retained within the oviduct until they are hatched. In the Python, which recently went through the process of incubation in the Zoological Gardens, the eggs were imbedded in the coils of the body; the temperature to which they were subjected (as ascertained by a thermometer placed in the midst of them) averaging 90° F., whilst that of the cage averaged 60° F.

which is needed in the case of cold-blooded animals; and we may notice two results of this application as very significant of the dynamical relation between Heat and Developmental Force,—first, that the period required for the evolution of the germ into the mature embryo is nearly constant, each species having a definite period of incubation,—and second, that the grade of development attained by the embryo before its emersion is relatively much higher than it is in cold-blooded Vertebrata generally; the only instances in which anything like the same stage is attained without a special incubation, being those in which (as in the Turtle and Crocodile) the eggs are hatched under the influence of a high external temperature. This higher development is attained at the expense of a much greater consumption of nutrient material; the store laid up in the "food yolk" and "albumen" of the Bird's egg being many times greater in proportion to the size of the animal which laid it, than that contained in the whole egg of a Frog or a Fish. There is evidence in that liberation of carbonic acid which has been ascertained to go on in the egg (as in the germinating seed) during the whole of the developmental process, that the return of a portion of the organic substances provided for the sustenance of the embryo, to the condition of simple binary compounds, is an essential condition of the process; and since it can scarcely be supposed that the object of this metamorphosis can be to furnish *heat* (an ample supply of that force being afforded by the body of the parent), it seems not unlikely that its purpose is to supply a force that concurs with the heat received from without in maintaining the process of organization.

The development of the embryo within the body, in the Mammalia, imparts to it a steady temperature equivalent to that of the parent itself; and in all save the *implacental* Orders of this class, that development is carried still further than in Birds, the new-born Mammal being yet more complete in all its parts, and its size bearing a larger proportion to that of its parent, than even in Birds. It is doubtless owing in great part to the constancy of the temperature to which the embryo is subjected, that its rate of development (as shown by the fixed term of utero-gestation) is so uniform. The supply of organizable material here afforded by the ovum itself is very small, and suffices only for the very earliest stage of the constructive process; but a special provision is very soon made for the nutrition of the embryo by materials directly supplied by the parent; and the imbibition of these takes the place, during the whole remainder of fœtal life, of the appropriation of the materials supplied in the bird's egg by the "food yolk" and "albumen." To what extent a retrograde metamorphosis of nutrient material takes place in the fœtal Mammal, we have no precise means of determining; since the products of that metamorphosis are probably for the most part imparted (through the placental circulation) to the blood of the mother, and got rid of through her excretory apparatus. But sufficient evidence of such a metamorphosis is afforded by the presence of urea in the amniotic fluid and of biliary matter in the intestines, to make it probable that it takes place not less actively (to say the least) in the fœtal Mammal

than it does in the Chick *in ovo*. Indeed, it is impossible to study the growth of any of the higher organisms,—which not merely consists in the formation of new parts, but also involves a vast amount of interstitial change—without perceiving that in the remodelling which is incessantly going on, the parts first formed must be removed to make way for those which have to take their place. And such removal can scarcely be accomplished without a retrograde metamorphosis, which, as in the numerous cases already referred to, may be considered with great probability as setting free constructive force to be applied in the production of new tissue.

If, now, we pass on from the intra-uterine life of the Mammalian organism to that period of its existence which intervenes between birth and maturity, we see that a temporary provision is made in the acts of lactation and nursing for affording both food and warmth to the young creature, which is at first incapable of adequately providing itself with aliment, or of resisting external cold without fostering aid. And we notice that the offspring of Man remains longer dependent upon parental care than that of any other Mammal, in accordance with the higher grade of development to be ultimately attained. But when the period of infancy has passed, the child that is adequately supplied with food, and is protected by the clothing which makes up for the deficiency of other tegumentary covering, ought to be able to maintain its own heat, save in an extremely depressed temperature; and this it does by the metamorphosis of organic substances, partly derived from its own fabric, and partly supplied directly by the food, into binary compounds. During the whole period of growth and development, we find the producing power at its highest point; the circulation of blood being more rapid, and the amount of carbonic acid generated and thrown off being much greater in proportion to the bulk of the body, than at any subsequent period of life. We find, too, in the large amount of other excretions, the evidence of a rapid metamorphosis of tissue; and it can hardly be questioned (if our general doctrines be well founded) that the constructive force that operates in the completion of the fabric will be derived in part from the heat so largely generated by chemical change, and in part from the descent which a portion of the fabric itself is continually making from the higher plane of organized tissue to the lower plane of dead matter. This high measure of vital activity can only be sustained by an ample supply of food; which thus supplies both *material* for the construction of the organism, and the *force* by whose agency that construction is accomplished. How completely dependent the constructive process still is upon Heat, is shown by the phenomena of reparation in cold-blooded animals; since not only can the rate at which they take place be experimentally shown to bear a direct relation to the temperature to which these animals are subjected, but it has been ascertained that any extraordinary act of reparation (such as the reproduction of a limb in the Salamander) will only be performed under the influence of a temperature much higher than that required for the maintenance of the ordinary vital activity. After the maturity of the organism has been attained, there is no longer any call for a larger measure of con-

structive force than is required for the *maintenance* of its integrity; but there seems evidence that even then the required force has to be supplied by a retrograde metamorphosis of a portion of the constituents of the food, over and above that which serves to generate Animal Heat. For it has been experimentally found that, in the ordinary life of an adult Mammal, the quantity of food necessary to keep the body in its normal condition is nearly twice that which would be required to supply the "waste" of the organism, as measured by the total amount of *excreta* when food is withheld; and hence it seems almost certain that the descent of a portion of the organic constituents of this food to the lower level of simple binary compounds is a necessary condition of the elevation of another portion to the state of living organized tissue.

The conditions of Animal existence, moreover, involve a constant expenditure of *Motor* force through the instrumentality of the Nervo-muscular apparatus; and the exercise of the purely *Psychical* powers, through the instrumentality of the brain, constitutes a further expenditure of force, even when no bodily exertion is made as its result. We have now to consider the conditions under which these forces are developed, and the sources from which they are derived.

The doctrine at present commonly received among Physiologists upon these points may be stated as follows:—The functional activity of the nervous and muscular apparatuses involves, as its necessary condition, the disintegration of their tissues; the components of which, uniting with the oxygen of the blood, enter into new and simpler combinations, which are ultimately eliminated from the body by the excretory operations. In such a retrograde metamorphosis of tissue, we have two sources of the liberation of force;—first, its descent from the condition of living, to that of dead matter, involving a liberation of that force which was originally concerned in its organization;*—and second, the further descent of its complex organic components to the lower plane of simple binary compounds. If we trace back these forces to their proximate source, we find both of them in the *food* at the expense of which the Animal organism is constructed; for besides supplying the material of the tissues, a portion of that food (as already shown) becomes the source, in its retrograde metamorphosis, of the production of the Heat which supplies the constructive power, whilst another portion may afford, by a like descent, a yet more direct supply of organizing force. And thus we find in the action of Solar Light and Heat upon Plants—whereby they are enabled not

* It was by Liebig ('Animal Chemistry,' 1842,) that the doctrine was first distinctly promulgated which had been already more vaguely affirmed by various Physiologists, that every production of motion by an Animal involves a proportional disintegration of muscular substance. But he seems to have regarded the motor force produced as the expression only of the vital force by which the tissue was previously animated; and to have looked upon its disintegration by oxygenation as simply a consequence of its death. The doctrine of the "Correlation of Forces" being at that time undeveloped, he was not prepared to recognize a source of Motor power in the ulterior chemical changes which the substance of the muscle undergoes; but seems to have regarded them as only concerned in the production of Heat.

merely to extend themselves almost without limit, but also to accumulate in their substance a store of Organic Compounds for the consumption of animals—the ultimate source not only of the materials required by animals for their nutrition, but also of the forces of various kinds which these exert.

Recent investigations have rendered it doubtful, however, whether the doctrine that every exertion of the functional power of the nervo-muscular apparatus involves the disintegration of a certain equivalent amount of tissue, really expresses the whole truth. It has been maintained, on the basis of carefully conducted experiments, in the first place, that the amount of work done by an animal may be greater than can be accounted for by the ultimate metamorphosis of the azotized constituents of its food, their mechanical equivalent being estimated by the heat producible by the combustion of the carbon and oxygen which they contain;* and secondly, that whilst there is not a constant relation (as affirmed by Liebig) between the amount of motor force produced and the amount of disintegration of muscular tissue represented by the appearance of urea in the urine, such a constant relation does exist between the development of motor force and the increase of carbonic acid in the expired air, as shows that between these two phenomena there is a most intimate relationship.† And the concurrence of these independent indications seems to justify the inference that *motor force* may be developed, like Heat, by the metamorphosis of constituents of food which are not converted into living tissue;—an inference which so fully harmonizes with the doctrine of the direct convertibility of these two forces, now established as one of the surest results of Physical investigation, as to have in itself no inherent improbability. Of the conditions which determine the generation of motor force, on the one hand, from the disintegration of muscular tissue, on the other from the metamorphosis of the components of the food, nothing definite can at present be stated; but we seem to have a typical example of the former in the parturient action of the Uterus, whose muscular substance, built up for this one effort, forthwith undergoes a rapid retrograde metamorphosis; whilst it can scarcely be regarded as improbable that the constant activity of the Heart and of the Respiratory muscles, which gives them no opportunity of renovation by rest, is sustained not so much by the continual renewal of their substance (of which renewal there is no histological evidence whatever) as by a metamorphosis of matters external to themselves, supplying a force which is manifested through their instrumentality.

To sum up: The Life of Man, or of any of the higher Animals, essentially consists in the manifestation of Forces of various kinds, of which the organism is the instrument; and these Forces are developed

* This view has been expressed to the author by two very high authorities, Prof. Helmholtz and Prof. William Thomson, independently of each other, as an almost necessary inference from the data furnished by the experiments of Dr. Joule.

† On these last points reference is especially made to the recent experiments of Dr. Edward Smith.

by the retrograde metamorphosis of the Organic Compounds generated by the instrumentality of the Plant, whereby they ultimately return to the simple binary forms (water, carbonic acid, and ammonia,) which serve as the essential food of vegetables. Of these Organic Compounds, one portion (*a*) is converted into the substance of the living body, by a constructive force which (in so far as it is not supplied by the direct agency of external heat) is developed by the retrograde metamorphosis of another portion (*b*) of the food. And whilst the ultimate descent of the first-named portion (*a*) to the simple condition from which it was originally drawn, becomes one source of the peculiarly Animal powers—the *psychical* and the *motor*—exerted by the organism, another source of these may be found in a like metamorphosis of a further portion (*c*) of the food which has never been converted into living tissue.

Thus, during the whole Life of the Animal, the organism is restoring to the world around both the *materials* and the *forces* which it draws from it; and after its death this restoration is completed, as in Plants, by the final decomposition of its substance. But there is this marked contrast between the two kingdoms of Organic nature in their material and dynamical relations to the Inorganic world,—that whilst the Vegetable is constantly engaged (so to speak) in raising its component materials from a lower plane to the higher, by means of the power which it draws from the solar rays, the Animal, whilst raising one portion of these to a still higher level by the descent of another portion to a lower, ultimately lets down the whole of what the Plant had raised; in so doing, however, giving back to the universe, in the form of Heat and Motion, the equivalent of the Light and Heat which the Plant had taken from it.

ON MILK, AND DAIRY ARRANGEMENTS.

By Dr. AUGUSTUS VOELCKER, Consulting Chemist to the Royal Agricultural Society of England.

AMONG the alimentary materials so bountifully supplied to man, there are few that may rank in importance by the side of the fluid whose constitution we are about to examine. Distinguished by a just combination of flesh-forming and fat-producing elements, with those salines which are best adapted for preserving the solution of the solid materials; remarkable for the facility with which the digestive system appropriates its nutriment; time-honoured as the support of helpless infancy; symbolical of mildness and sweetness, its very simplicity would seem a claim to its exemption alike from suspicion or inquiry; but, alas! for the materialism of the age, its value may be represented by so many pence, its mildness is perverted by adulteration, and the food of babes is too often suggestive of chalk and water, with a judicious thickening of brains and treacle. Milk, like everything else, being reducible to a question of money, we do not hesitate to

adopt means to ensure, as far as possible, that we obtain our money's worth. Professing, as we do, a decided preference for the healthy and natural fluid, over any artificial representation of it, however superior in the estimation of the vendor, we call in the aid of science, to inform us what we ought to have, even if it gives us, at the same time, the miserable satisfaction of knowing that we have it not.

General Composition and Characters of Milk.— Milk is the secretion derived from the blood supplied to the mammary gland of the female animal, of the class mammalia. It is never produced in any quantity until after parturition; but during the latter part of utero-gestation it occurs in appreciable amounts, and instances are on record where it has been obtained from the gland of an animal previous to impregnation. The fluid secreted before parturition, and for some time afterwards, is called Colostrum, and contains a number of large corpuscules, filled with oil globules, distinguished as the "Colostrum Corpuscules."

Milk is white in colour, opaque, and has an agreeable sweetish taste; the odour is faint, but peculiar.

Its density is greater than that of water. Cows' milk, of good quality, has a specific gravity of about 1030; human milk 1020; Goats' and ewes' milk 1035 to 1042, and asses' milk 1019, compared with water at 1000.

The chemical reaction seems to be in a measure dependent upon the food, as might reasonably be expected, Carnivora giving milk possessing an acid reaction, and Herbivora an alkaline milk. Although apparently homogeneous, it may be separated into cream (which consists of oil globules, formed by thin envelopes of casein (curd), enclosing the fats of butter), curd, or casein, albumen, milk-sugar, and mineral matters, consisting chiefly of phosphate of lime and magnesia, as bone, earth, and salts of potassium and sodium, with some oxide of iron.

Cream—varies in composition, according to the circumstances under which it is produced. Four different samples analysed in my laboratory yielded the following results:—

	I.	II.	III.	IV.
Water	74·46	64·80	56·50	61·67
Butter (pure fatty matters) .	18·18	25·40	31·57	33·43
*Casein	2·69	7·61	8·44	2·62
Milk-sugar	4·08			1·56
Mineral matters (ash) . . .	0 59	2·19	3·49	0·72
	100·00	100·00	100·00	100·00
* Containing nitrogen .	·43	.. ..	.. ..	·42

Cream is lighter than milk, but slightly denser than pure water; consequently it sinks in distilled water. No. 1 was skimmed off after standing for 15 hours, and was found to have a specific gravity of 1·0194 at 62° Fahr. The specific gravity of two other samples of

cream which stood 48 hours was 1·0127 at 62° Fahr., and 1·0129 at 62° Fahr. Rich cream, I find, has a lower specific gravity than thin cream mixed with a good deal of milk, such as the sample analysed under No. 1.

No. 2 may be taken as representing the composition of cream of average richness. It then contains about one-fourth its weight of pure butter.

These differences in the composition of cream fully explain the variable quantities of butter which are produced by a given bulk of cream.

On an average, one quart of good cream yields from 13 to 15 ounces of commercial butter. When very rich in fat, it will yield rather more. Thus Mr. Horsfall states that a quart of cream yielded 1 lb. of butter when the cows were at grass, and 22 to 24 ounces when they were housed and fed on rape-cake, bran, and other substances rich in oil.

The portions of cream which first rise, are thin, but rich in fat; this is due to the rupture of some of the oil globules during the milking, and subsequent agitation to which milk is exposed; the light fatty contents thus liberated naturally rise quickly to the top of the vessel in which the milk is set.

Good and poor milk differ mainly in the proportion of cream present; the appearance may not be much varied, except in extreme cases; consequently, for the determination of the quality, more reliable tests are required than the mere inspection of the fluid; and as a preparatory step to the consideration of the evidences afforded by the specific gravity under various conditions, a few observations may be offered upon the microscopic examination of milk in health and disease.*

Microscopic Examination of Milk in Health and Disease.—It must be some consolation to those who delight in miserable anticipations of dreadful mixtures in their daily food, to know that we possess a method of detecting, with absolute certainty, those combinations of "brains, chalk, and starch," a haunting suspicion of which makes the morning and evening meal distasteful.

Without positively asserting that such adulterations never exist, we may aver that we have never met with an instance. Foreign matters, of a nature unsavoury enough, and even unwholesome, we sometimes find, but they are the consequences of a diseased condition, or of an absence of common cleanliness. Such things as particles of dirt, from the milker's hands or the cow's udder, and cuticular scales from the same sources, are common enough. Globules of pus and blood discs are also found less frequently, but still oftener than we like to believe. It will not be thought that the microscope should be the companion to the breakfast-table: but in all cases where there is the least cause for suspicion, its revelations are infallible, and set at rest the doubt that is worse than certainty.

* The substance of the remarks on the microscopic appearance and the illustrations have been kindly contributed by my friend and former colleague, Professor G. T. Brown.

XUM

Good milk, under a tolerably high power, presents the appearance seen in our sketch (Fig. 1). Clustering masses of oil globules, the majority of uniform size, may be observed interspersed with a few larger, and a number of smaller ones, some being no more than fat granules of extreme minuteness. As occasional objects we may expect a few dirt particles, epithelial scales, or now and then two or three hairs. The appearance of the milk globules is so characteristic, that adventitious matters are in most cases discovered at once.

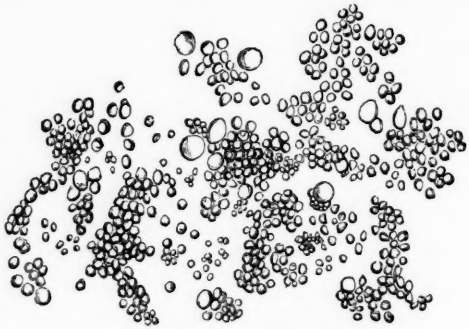


FIG. 1.—Healthy Milk.

From the number of oil globules collected together we may form some idea of the richness of the milk examined; but the microscope is not the best instrument for testing the proportion of oil globules in any given specimen, as in even very poor milk they will probably be collected in some parts of the field in sufficient numbers to lead to an erroneous judgment. In our illustration (Fig. 2) is represented a drop of milk so diluted with water as to be nearly transparent. The oil globules are seen in considerable numbers, although not in such masses as we find in the undiluted fluid. In portions of the specimen we should find the quantity apparently much increased by the natural flow of them to the most dependent part, and at *a* is an epithelial scale, of which occasionally small masses are discovered.

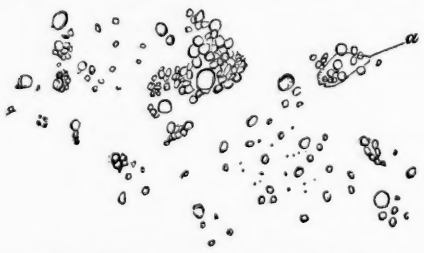


FIG. 2.—Healthy Milk largely diluted with Water.

In the event of pus, or blood, being mingled with the milk, it is evident that the gland is diseased; such elements could hardly be introduced by accident, and of a certainty would not be so intentionally. The appearance of the pus globule is very marked, as will be seen by reference to our drawing (Fig. 3, *a*). The faint outline, compared with the well-marked boundary of the oil globule, with the granular character and greater size, will be sufficiently distinctive; further evidence may be obtained by the addition of a small quantity of acetic acid, under whose action the nuclei of the pus cells soon become apparent, as at *b* and *c*, while the cell wall is gradually dissolved.

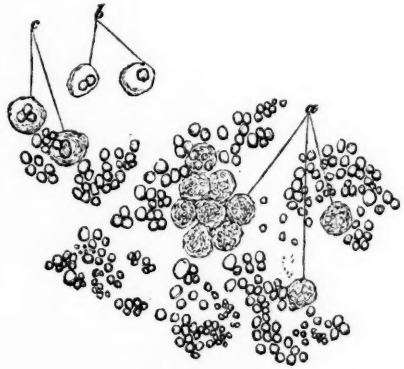


FIG. 3.—Milk with Pus.

The detection of blood discs is not so easy, for although they are essentially different from milk globules, their shape is materially altered by combination with the milk, which causes them to swell up and lose their peculiar dark centre. After the specimen, however, has been allowed to dry on the glass, the characteristic appearance is restored, and the blood discs are then very easily recognized.

The last Figure (4) represents blood discs in the milk, after being

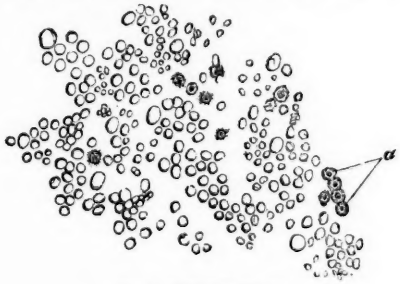


FIG. 4.—Milk with Blood.

allowed to remain for some hours on the glass. At *a* there are five of them, and others will be seen among the milk globules. Some of the blood discs have assumed a stellate form, but the dark centre is equally apparent in each.

On the subject of the Adulteration of Milk, and the means of Detection, nearly every writer mentions a number of materials said to be used in London, and other large towns, for the purpose of so improving the colour and consistency of milk that the water added to increase the bulk may not be so readily discovered. Whatever skill the milkman of the olden time may have possessed in this department of his trade, it seems to us that he of the present day is deficient in the modesty which afflicted his predecessor. We find now, at any rate, the "cerulean fluid" poured unblushingly into our jugs without an effort to disguise the sophistication, which, however harmless, not the less defrauds us of our due percentage of the coveted cream. So *honestly*, indeed, is the practice indulged in that we know more than one dairyman of tender conscience who professes to supply milk of undoubted quality for the consumption of invalids and babies, while the robust are treated to an attenuation of the most unsubstantial kind.

The prevalent system of adulteration, we are convinced, consists in the admixture of water. Where the demand at certain seasons particularly exceeds the supply, the cow with the iron tail never fails to meet all demands however unreasonable, and doubtless deserves the reputation, so long ago acquired, of being the milkman's best friend.

Besides the intentional dilution of milk, there is a natural dilution dependent upon the derangement of the secretive function by the food, as is the case when such matters are supplied as distillery waste, bran mashes, grass from irrigated meadows, mangold tops, and acid slops, obtained by allowing barley meal, cabbage leaves, and other vegetable matters mixed with a great deal of water to pass through the lactic acid fermentation. The effect of such food is to induce the secretion of a large amount of water, and thus of necessity a poor quality of milk.

Whether the dilution of milk be intentional, or the result of certain influences acting upon the system, is to the consumer a matter of secondary importance, the great question being with him whether the milk is of good or bad quality.

My own experience leads me to conclude that a specimen of milk is rich when it contains 12 per cent. of solid matters, and about 3 per cent. of pure fat; anything above this is of extra rich quality.

Good average milk contains 10 to 11 per cent. of dry matter, and about 2½ per cent. of pure fat. It yields 9 to 10 per cent. of cream.

Poor milk, whether naturally or artificially diluted, contains 90 per cent. of water, and less than 2 per cent. of pure fat, and yields only 4 to 8 per cent. of cream.

For the purpose of determining the quality of milk, numerous instruments have been at various times invented; some of them are of doubtful utility, and nearly all require great tact on the part of the manipulator.

Hydrometers, or lactometers, specially adjusted for testing milk, may be obtained at a cheap rate at the philosophical instrument makers, and although not capable of furnishing evidence of so exact a nature as would be obtained by analysis, these are, nevertheless, very much more useful indicators than anyone would be inclined to believe, who did not know how far the specific gravity of milk is a test of its quality.

The lactometer was never intended to indicate the relative richness of good samples of milk, but to point out whether samples of a fair or doubtful appearance had been watered, or were of a naturally defective composition; and this purpose it satisfactorily fulfils.

Experiments were instituted in my laboratory for the purpose of ascertaining the influence of dilution upon the specific gravity, and the quantity of cream thrown up. Water being the standard at 1000; cream 1012 to 1019, and good milk 1·0320; the temperature being always 62° Fahr.

The following results were obtained:—

	Specific Gravity.	Percentage of Cream in bulk.
Pure milk at 62° Fahr.	1·0320	11½
„ and 10 per cent. of water at 62° Fahr.	1·0315	10
„ 20 „ „	1·0305	9
„ 30 „ „	1·0290	8
„ 40 „ „	1·0190	6
„ 50 „ „	1·0160	5

Experiments made upon milk after being skimmed gave the following:—

	Specific Gravity.
Skim milk	1·0350
„ with 10 per cent. water . . .	1·0320
„ 20 „ . . .	1·0265
„ 30 „ . . .	1·0248
„ 40 „ . . .	1·0210
„ 50 „ . . .	1·0180

From these investigations it appears:—

1. That good new milk has a specific gravity of about 1·030.
2. That skim milk is a little more dense, being about 1·034.
3. That milk which has a specific gravity of 1·025 or less, is mixed with water, or naturally very poor.
4. That when milk is deprived of about 10 per cent. of cream, and the original volume is made up by 10 per cent. of water, the specific gravity of such skimmed and watered milk is about the same as that of good new milk; this circumstance, however, does not constitute any serious objection to the hydrometer, as milk skimmed to that extent cannot be mixed with water without becoming so blue and transparent, that no instrument would be required to detect the adulteration.
5. That when unskimmed milk is mixed with only 20 per cent. of

water, the admixture is indicated at once by the specific gravity of about 1·025.

6. That for these reasons the hydrometer or "lactometer" which gives the specific gravity of milk is well adapted for detecting the admixture of water, or to show an unusually poor quality of the unadulterated milk.

1. *Circumstances affecting the Quality and Quantity of the Milk.*—The period of the milking at which the sample is taken. During the process of milking, that which is first drawn off is thin and poor, and gives little cream: improving during the flow—the last drawn—the "strippings"—is the richest in quality, yielding better cream, and consequently more butter.

Experiments by Reiset and Pelligot have established the fact that considerably more solid matter and pure fat are contained in the milk last drawn from the udder.

This superior richness of the last-drawn milk has an important bearing upon the question of milking machines. The new American cow-milking machine fails to strip the udder, according to the united testimony of all who have tried it. Such a fundamental defect must militate against its general introduction into England, and has led to its disuse in the United States, as I am informed by the secretary of one of the most influential State Agricultural Societies.

It has, to my own knowledge, been tried by several excellent judges, who remain silent as to its merits, not liking to accept the unpleasant office of condemning and declining, as judicious men, to bestow undeserved praise.

2. *Distance from the time of Calving.*—The first milk, or colostrum, is thicker and yellower than ordinary milk, coagulates by heating, and contains an unusually large quantity of casein or curd.

In ten or twelve days from the time of calving, the milk assumes its ordinary condition, and the flow then becomes very plentiful; but after a month, or thereabouts, the yield gradually diminishes until the animal runs dry, usually in about ten months, unless when succulent and stimulating food is given to excite the continuance of the secretion for a longer time.

3. *Season of the Year and Food.*—In the spring and early part of summer milk is abundant, and of good flavour. As the season advances the supply is diminished, but becomes richer in butter. The same quantity of milk which in August scarcely yielded 3 per cent. of pure butter and 3 per cent. of curd, in November produced 4½ per cent. of butter and 3½ per cent. of curd.

A series of observations, made for the purpose of ascertaining the variations in the quality of the milk on the same farm throughout the year, convinced me that the supply of food was chiefly concerned, the richness or poverty of the diet being in all cases represented by the quality of the milk yielded.

In November and December the cows had meal-nut oil given to them, which is the refuse left after pressing ground kernels of the palm-nut. This substance, when of good quality, not too hardly

pressed, is very nutritious and rich in fat,* and was found to exercise a decided influence upon the proportion of butter in the milk.

Brewers' grains are generally considered to possess a peculiarly stimulating effect upon the formation of the mammary gland. M. Struckman, of Wartburg in Germany, in 1855, published some feeding experiments, the results of which are of such practical importance as to justify an analysis of them here.

Four good and four bad cows were selected, and the diet included brewers' grains, mangolds, oat-straw, and rape-cake.

"Most milk was produced by 5½ lbs. of rape-cake, 36 lbs. of mangolds, and 25 lbs. of oat-straw daily to each animal."

A reduction of 9-10ths lb. of rape-cake led to a decrease of 6·55 litres per cow daily; thus 1 lb. of rape-cake represents an average of 1⅛ lb. of milk. A diminution of 6 lbs. of grains was followed by a reduction of 6·72 litres of milk; thus 1 lb. of grains appears to have produced ¼ lb. of milk.

When 18 lbs. of brewers' grains were replaced by 4½ lbs. of rape-cake, the yield of milk was nearly the same; accordingly, 1 lb. of rape-cake was equal to 4 lbs. of grains, in its power of producing milk.

Rape-cake produced milk richer in butter; grains, however, produced butter of more delicate flavour.

During the experiments, the superior cows were found to be most influenced by the changes of food. In the inferior animals the yield was tolerably uniform, notwithstanding they were subjected to the same dietetic changes.

4. *Morning and Evening Milk.*—Popular opinion ascribes to the morning's milk a superiority in quality. Observations on this point do not sanction the conclusion, but rather tend to establish the conviction that the quality of the milk depends upon the food supplied some hours before the cows are milked.

If the food during the day has been plentiful and good, and the evening's food innutritious and scanty, the evening milk is of superior quality to that drawn on the following morning. Should the cows get a good supply of rich food in the evening, after having been stunted or fed on poor food during the day, the following morning's milk will be of a higher quality than that of the preceding evening.

Out of thirty-two samples of morning and evening milk, I found the morning's produce to be richer in four cases, and poorer in eight cases; whilst in four instances there was no perceptible difference.

* *Composition of Palm-nut Kernel-meal, by the Author.*

	No. 1.	No. 2.
Water	9·85	7·01
Fatty matters	24·14	22·45
† Albuminous compounds (flesh-forming matters)	16·43	12·90
Gum, sugar, and digestible fibre	26·60	26·61
Woody fibre (cellulose)	19·58	27·70
‡ Mineral matters (ash)	3·40	3·33
	100·00	100·00
† Containing nitrogen	2·63	2·02
‡ Containing sand	·63	·97

5. *Breed and Size of the Animal.*—It may be accepted as a fact, that animals which indicate a peculiar aptitude to fatten, are not likely to be distinguished as milkers; we do not assume that physiologically the two qualifications are incompatible, rather preferring the alternative conclusion that so much attention has been devoted to the selection of stock possessing the requisite qualities for feeding, that the milking capabilities have been passively ignored by the breeder. Pure Shorthorns, as a breed, are commonly objected to on the ground of their deficiency in this respect, although the circumstances of some families of pure bred animals being celebrated for the amount and quality of their milk, would seem to indicate that the stigma is too indiscriminately affixed to this breed.

The Yorkshire cow, essentially a Shorthorn, is the favourite of cowkeepers in London and other large towns, surpassing all others in the quantity of its yield, although the quality loses by comparison with that of smaller breeds.

If breeders would make it an object to cultivate both the feeding and milking qualities, there is nothing in previous experience opposed to a successful result.

Small breeds, or small individuals of large breeds, usually give a better quality of milk from the same food than large ones. The larger animals giving a better return in quantity, and furnishing more meat for the butcher, are, however, more profitable.

Where good quality is the main object, Alderneys perhaps will give most satisfaction, for they give richer cream than any other breed in common use in this country. The small Kerry cow, and the miniature Breton, produce extremely rich milk in quantity proportioned to their size.

For dairy purposes in cheese districts the Ayrshire are justly celebrated; indeed they seem to possess more completely than other breeds the power of converting the elements of food into cheese and butter; they do not, on the other hand, lay on fat and flesh well.

A cow of this breed bought by the Duke of Atholl from Mr. Wallace, Kirklandholm, produced from April 11, 1860, to April 11, 1861, 13,456 lbs., or about 1305 gallons of milk, which at 8*d.* per gallon would be worth 43*l.* 10*s.*

For general dairy purposes Shorthorns are probably the most useful. The dairy farmer will naturally select those that are more distinguished for milking qualities than for their tendency to fatten, at the same time not losing sight of the latter qualification, which will tell when the animals are no longer profitable for his dairy.

Health, Constitution, and Age might be enlarged upon as circumstances affecting the composition and quality of the milk: their influence, however, is too obvious to require more than a passing mention.

On Dairy Arrangements.

Aspect.—Our great aim should be to secure a position favourable for the preservation of dryness and uniformity of temperature all the year round. The best aspect is one facing the north, although this

cannot be considered essential so long as the room can be kept dry, well ventilated, and protected by blinds from the direct rays of the sun.

Construction.—With the intent to secure the coolness which everyone knows to be desirable in summer, the dairy is sometimes built at a lower level than the ground. Underground dairies, however, are frequently damp; so that on a clay soil it is better to choose the lesser of two evils, and to build on a level with the ground.

In such localities, it is well to put a drain all round the building.

The walls should be thick, and if of stone, lined inside with brick. Presuming the dairy to be a separate structure, the roof should be covered with straw, which, being a bad conductor, best ensures a uniform temperature. Stonesfield slates or similar limestone flag-stones, or if these cannot be procured, common red tiles should be used in preference to black roofing slates, which, being good conductors, become very hot in summer. The floor should be of stone: large flag-stones well set in cement appear to me preferable to ornamental or common small tiles; as it is an object to lessen the number of cracks in which water may lodge, rendering the floor constantly wet.

Ventilation.—A great defect in many of the dairies in England is the want of proper ventilation. This is a fertile source of dampness, so especially detrimental to the preservation of milk. One of the most effectual and inexpensive means of providing for a renewal of air, is to put up a perforated zinc grating 3 or 4 inches broad, which may be carried all along the tops of the windows. In addition, a whole window made to open and shut may be furnished with perforated galvanized sheet zinc.

Recourse may be had to more elaborate appliances; but the more complicated the apparatus the more difficult it will be to keep it in working order in the hands of the dairy attendants.

Temperature.—An equable heat being necessary in winter, it is best supplied by hot-water pipes; since, with a stove or open fire, it will be impossible to regulate the degree with sufficient nicety. Too much heat favours decomposition, and too little is unfavourable to the rapid separation of the cream.

A temperature not higher than 65° nor lower than 60° Fahr. is most conducive to the rising of the milk globules.

An accurate thermometer should be kept in the dairy; and on no account should the temperature be allowed to fall below 55°. Attention should be directed to the maintenance of a uniform degree of 60 as far as it is possible under all circumstances.

Benches of slate or marble are superior to wooden ones; but should economical considerations lead to the selection of wood, it should be painted, in order that any milk accidentally spilled may be readily removed. Milk easily penetrates a material so porous as wood, and is not readily removed. Cold water is quite ineffective, and even after the use of hot water, enough milk may remain in porous wood to generate an active ferment.

Milk-pails which are made of bright tin are decidedly better

than wooden ones; unless great pains are bestowed in scouring the latter with boiling water, they taint the milk very quickly: tin pails can be always kept sweet and bright.

Pans should be constructed of glass, tinned iron or well-glazed earthenware; all porous materials are objectionable. Zinc pans are said to throw up more cream than those of other material; but zinc is readily oxidized, and like brass and tinned copper, however unobjectionable when kept clean, it may, in the hands of careless dairy-maids, furnish enough poison to injure the health of the consumer. Glass pans are easily kept clean, and well adapted for keeping milk and cream in a sweet condition. They are of course more liable to be broken, and therefore more expensive in the end than tin pans.

Deep pans are objectionable, as the quicker the cream can be made to rise, the sweeter it will be when used for churning, and the greater also will be the yield of butter according to Sennart's experiments.

Some allow the cream to become sour before they remove it; but, although in this state it appears more bulky, and of thicker consistency, it does not produce so much, nor so good a quality, of butter.

Shallow vessels are better than deep pans for another reason. If the milk is drawn from the cow into a shallow tinned-iron pan, the milk is soon reduced from 90° to 60°, and then, in a good dairy may be kept from thirty-six to forty-eight hours at a season when, in deeper vessels, it would soon turn sour.

Before the milk is put into pans it should be run through a straining-cloth. The accompanying sketch (Figs. 5 and 6) represents a vessel made of tinned-iron, with the straining-cloth tied round the spout.

Fig. 5.

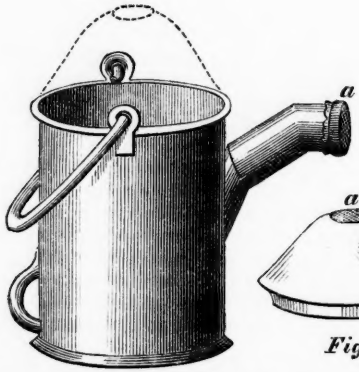


Fig. 6.

Cleanliness.—In no department of human industry is cleanliness more emphatically a virtue than in everything connected with the dairy. Too much attention cannot be bestowed upon the room itself, as well as upon the pails, pans, and other utensils.

The injudicious and wasteful employment of water must be deprecated. However convenient a good supply undoubtedly is, it must not be forgotten that a damp floor and moist atmosphere are to the last degree injurious. Whatever water is used should be scalding hot, and its evaporation assisted by a current of air. All the utensils should be washed without delay, instead of being set aside until wanted. The dairy-maid should not show her zeal for keeping the dairy clean by splashing water about. Above all, she should prevent men or women entering her domain with dirty shoes, or in any way bringing dirt into the dairy.

In wet weather the introduction of dirt may be unavoidable, but it may be reduced to a minimum by having a good scraper and rough doormat at the entrance, as well as a pair of wooden shoes, which may be easily slipped on and off, for each man who brings in the milk.

Anyone who doubts the efficacy of these simple means should visit North Brabant, which is justly celebrated for its excellent butter. Dairies, which are models for cleanliness, can be seen, not here and there, but almost universally throughout the district. It is, we are quite aware, difficult to ensure the proper conduct of a dairy with all the requisite exactitude, but the trouble is well bestowed, and cleanliness, like any other virtue, is its own reward.

PROCEEDINGS OF METROPOLITAN SOCIETIES.*

THE ROYAL ASTRONOMICAL SOCIETY.

THE contributions to the transactions of this Society have been, during the period which we are about to chronicle—namely, the months of November, December, and January—of an extremely interesting character, and the subject to which the largest amount of new information has been added is the physical character of the Sun.

Let us state by way of preface, however, that at the first meeting of the session, November 13, 1863, the business of the meeting commenced with an announcement from the chairman, Dr. Lee, V.P. (who presided in the absence of the President, the Astronomer Royal), to the effect that an Anglo-French astronomical treaty had been made, the contracting parties being M. Le Verrier, the director of the Paris Observatory, on the one side, and our own Astronomer Royal on the other; the object of which is so to divide the large amount of work that is usually exacted from national observatories between the two establishments so that, whilst nothing important is omitted, the astronomical observer shall have some relief at those seasons when the requirements of science press peculiarly heavy upon him.

The observations of the Moon, as our readers are aware, have ever been followed at the Greenwich Observatory with unfailing assiduity. Whilst that body passes the meridian in the evening, the addition of the planetary observations only adds to the labour of the Observatory in proportion to the number of observations; but when the moon is a morning observation, the evening observations of the planets add a very oppressive labour. In order to diminish this oppression on the staff, an arrangement of the following kind has been made between the directors of the two Observatories:—The Paris Observatory undertakes the planetary observations from full moon to new moon, the Greenwich Observatory those from new moon to full moon. The small planets are, with some few exceptions, observed only between the hours 10 and 13, solar time. It is to be hoped that this example will be followed, not only by public Observatories, but by the many private establishments which are in the habit of doing good work. A very great amount of labour and time is no doubt wasted through the want of *combined* effort.

We must, however, for the present pass over the papers read at the November meeting, and refer to two by the Rev. W. R. Dawes, at those of December and January, on "*The Telescopic Appearance of the Exterior Envelope of the Sun and of its Spots.*"

Solar physics always command a great deal of interest, and the name

* Our limited space, and still incomplete organization, necessitate the postponement of articles on the Proceedings of two or three Metropolitan Scientific Societies.

of Mr. Dawes is so well known in that particular field of research that any paper from him on the subject is heard with respect. The author commenced by pointing out the danger there was that observers, furnished with the more powerful telescopes now generally in use for solar inspection, would consider as *new discoveries* what was really only the revelation of superior telescopic power; but which remained unrevealed in the diminished apertures formerly in use. This would be more likely the case where *new names* have been applied by a recent observer to phenomena long familiar to others, though previously unnamed. Mr. Dawes has therefore considered it advisable to describe very minutely appearances which were observed long ago, that the new observer should know precisely what has already been seen in good instruments. Such an explanation was undoubtedly needed, as it is calculated to save much anxiety to the unpractised observer.

With regard to the 'mottled' appearance of the solar surface, which is familiar to every observer, but in the description of which so many, and, to our minds, fanciful images have been used, Mr. Dawes makes the following remarks:—"Examined with a large aperture, such as 6 or 8 inches, it becomes evident that the surface is principally made up of luminous masses, imperfectly separated from each other by rows of minute dark dots,—the intervals between these dots being extremely small, and occupied by a substance decidedly less luminous than the general surface." . . . "This gives the impression of a division between the luminous masses, especially with a comparatively low power, which, however, when best seen with high powers, is found to be never complete." . . . "The masses thus incompletely separated are of almost every variety of irregular form;—the rarest of all, perhaps, being that which is conveyed to my mind by Mr. Nasmyth's appellation of '*willow-leaves*;' viz. *long*, *narrow*, and *pointed*."* . . . "Indeed the only situation in which I have usually noticed them to assume anything like that shape, is in the immediate vicinity of considerable spots, on their *penumbræ*, and frequently projecting beyond it irregularly for a small distance on to the *umbra*."

Mr. Dawes negatives the opinion, held by Sir John Herschel, amongst others, and mentioned in his *Outlines*, that the minute dark dots are ever in a state of change. He believes, from his own experience, that when observers have fancied they detected change, it was due to the influence of atmospheric action. There is, however, an exception to this state of quietude, "in the immediate vicinity of spots which are

* At the next meeting of the Society, a letter from Mr. Nasmyth to Mr. Hodgson was read, in which the former gentleman made the following remarks concerning the "willow leaves":—

"The filaments in question are seen, and appear well defined, at the edges of the luminous surface where it overhangs the 'penumbra,' as also in the details of the penumbra itself, and most especially are they seen clearly defined in the details of 'the bridges,' as I term those bright streaks which are so frequently seen stretching across from side to side over the dark spot. So far as I have yet had an opportunity of estimating their actual magnitude, their average length appears to be about 1,000 miles, the width about 100."

"There appears no definite or symmetrical arrangement in the manner in which they are scattered over the surface of the sun; they appear to lie across each other in all possible variety of directions."

either rapidly enlarging or closing. It is under these circumstances especially that the luminous masses are found to become more elongated. This is also more remarkably the case when they are *preparing for a rush across a chasm*, and thus forming those luminous bridges which so often intersect considerable spots."

After detailing some more facts connected with the formation of these luminous bridges, the author draws attention to the distinction between the true or blacker *nucleus*, and the *umbra*. In almost all large spots the former is found to occupy some portion of the latter; and the author thinks that the establishment of the fact of the existence or absence of such black nucleus is "sufficient to determine, or at least to throw much light upon the *origin* of the spot; and that the origin of those in which the nucleus exists is widely different from the origin of those from which it is absent."

The author's second paper on the same subject, delivered in January, was to some extent a recapitulation of the first, after which he proceeded to communicate further details concerning the solar spots.

These he divides into two classes, which he names the *profound* and the *superficial;* and thus describes the characteristics of each.

"The *profound*.—In this class I should include those which give evidence of involving all the visible envelopes, the disturbance being observable through them all, and down to what appears to be the body of the sun itself."

"The *superficial spots*.—These appear, from the general tenour of my observations, to be almost always produced by convulsions of some kind in the photosphere itself, or at a small depth below it. But, from the extraordinary variety of the effects, I confess that I am not prepared to add anything to the suggestions already advanced as to the character of those convulsions, or the means by which they may be produced."

With regard to the probable formation of the *profound* spots, Mr. Dawes arrives at the following conclusions :—

"An immense volume of some non-inflammable gas, discharged with prodigious force from the body of the sun by volcanic or some similar agency, bursts through the *cloudy stratum*, rolling back on all sides the displaced portion of that stratum, and producing that heaped-up appearance at its inner and lighter edge. The *black hole* produced in the stratum by this volcanic eruption forms the *nucleus* of the spot."

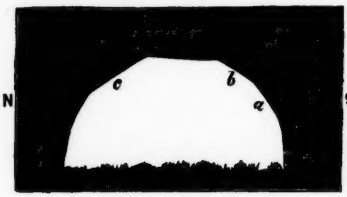
"Having passed through the cloudy stratum, the evolved gas comes within the influence of the heating power of the self-luminous penumbral stratum; and being greatly expanded thereby, its increased volume removes a far larger area of this second stratum than of the first; thus laying bare a considerable portion of the upper surface of the cloudy stratum, and producing the *umbra* of the spot. Here, too, the rolling back of the removed portion causes a heaped-up and brighter appearance at the inner edge of the penumbra. Being still further heated, and expanded by approaching the photosphere, a similar effect is produced upon this upper stratum, but to a far greater extent; and a much larger portion of the photosphere is thrown off on all sides, which being, as before, rolled back upon the rest, gives the appearance of a

heaping-up of the luminous masses at the extreme edge of the spot." . . "The *rotary* motion of a *profound* spot may be produced by the exploded gas having acquired a whirlwind sort of action, and thus carrying round the parts of the different strata affected by it in the same direction."

At the close of the paper Mr. Dawes gives as an addendum some extracts from an elaborate paper by Sir William Herschel, printed in volume XCI. of the 'Philosophical Transactions,' in which the observations of many years are discussed; and which seem in many particulars to bear out the observations of Mr. Dawes.

Next to the sun, the moon is perhaps the most interesting body to the amateur observer, and we generally have a paper of some kind about her at one or more meetings during the session. Mr. Birt did not fail with his favourite topic at the first meeting, and gave the Fellows a paper on the *Extension of Lunar Nomenclature*. Many craters still remain on our maps unnamed, whilst there are several that have been altogether omitted, and that too on our best lunar maps. These latter Mr. Birt has laid down; whilst to those wanting names he has, in conjunction with Dr. Lee, of Hartwell, given designations. A list is appended of the spots so named, with their numbers (in accordance with those adopted by the Rev. T. W. Webb), together with the selenographical longitudes and latitudes of each.

The moon also furnished the subject of a paper by the Rev. H. C. Key, entitled "*On Certain Depressions on the Moon's Western Limb*;" and as the paper contains some observations of a novel character, we shall treat somewhat more fully of the subject. The author does not mean the general depressions on the moon's surface, but as he himself expresses it, "of depressions of large area—not of comparatively small gullies, lying between elevated ranges, which are constantly to be seen projected on the limb, but of vast tracts, the general level of which lies very considerably beneath the mean level of the moon's surface." Mr. Key took great pains to satisfy himself that the instrument was in proper adjustment, and that the phenomenon he observed was not due to any defect in the telescope. Perhaps the best way of showing our readers the extraordinary nature of these depressions, will be to present them with a copy of the drawing illustrating the paper in question.



The circumstances of the discovery are thus related:—"Having mounted my new 12-inch glass speculum, I had for some time past

been making experiments with it, in the unsilvered state, upon celestial objects, with the view of ascertaining how far a diminution of light and consequently of the evils of irradiation, combined with a large aperture, might be of advantage in particular cases. For this purpose, on the 20th of September, at about 6 p.m, before the sun had set, I turned the telescope upon the moon, then a few hours past her first quarter. I had no sooner focussed the telescope (power 120) than I was astounded at observing that the limb of the moon was entirely *out of shape*; that it was, in fact, irregularly polygonal, as if several large segments had been cut off the spherical limb—not the terminator."

Upon observing these remarkable appearances the author wrote to his friend, Mr. Webb, who, on examination, at once detected them; and proved their existence beyond a doubt by the use of the wire of the micrometer. Subsequently, September 25th, when Mr. Key again examined the limb he was only able to trace a very faint appearance of a depression. From this circumstance the author is led to believe that the maximum visibility of these depressions only lasts for a short period; and that the effect of irradiation would render their detection in ordinary instruments extremely difficult.

Now that this extraordinary phenomenon has been once discovered, it is to be hoped that observers will direct their attention to so interesting a subject, and will provide themselves with instruments calculated to exhibit more perfectly the true form of the limb. For this object Mr. Key strongly urges the adoption of the plain, in addition to the silvered speculum. We should state that the drawing was made from memory the following day, and although it but represents roughly the positions of the depressions, he does not consider them exaggerated. The deepest depression below the surface of the moon he estimates at about 25 miles.

A paper, "*On the Origin of the apparent Luminous Band which, in partial Eclipses of the Sun, has been seen to surround the Visible Portion of the Moon's Limb*," was communicated to the Society by G. B. Airy, Astronomer Royal. The object of this paper was "to show, by optical investigation, that no refraction can cause a change in the apparent brightness of the surface viewed." As the paper was necessarily of a purely mathematical character, we shall content ourselves with merely giving our readers its general results. Having arrived, from this treatment of the subject, at the conclusion that "refraction by a lunar atmosphere cannot explain the more luminous band which appears to surround the moon's limb where it crosses the sun's disc," the author goes on to state his opinions on its real origin in very positive terms: "I have no difficulty in explaining to myself the origin of the luminous band in question. It is strictly an ocular nervous phenomenon; not properly subjective, but sensational—a mere effect of contrast. I have seen it so frequently under circumstances very different from these, that I cannot have the smallest doubt on the matter."

In this paper the author entertains views antagonistic to those previously expressed by Professor Challis, in a paper contained in the 'Monthly Notice,' June 12, 1863, and at the meeting in January last Professor Challis communicated a paper "*On the Calculation of an*

Optical Effect of Atmospheric Refraction," which is, in fact, a reply to Mr. Airy's. The latter observer, in his argument, assumed the effect of an atmosphere to be analogous to that of a convex lens, and on this assumption investigated the case mathematically. But Professor Challis contends that the courses of rays passing through a medium of variable density, like the atmosphere, cannot be similar to those passing through a convex lens; and that, therefore, in investigating the point at issue, respect must be had to the variation of the refractive index, in passing from one point of the medium to another.

The Astronomer Royal has also contributed a few remarks on the amount of light given by the moon at the greatest stage of the 1863 June 1 eclipse. As this eclipse, from the cloudless state of the sky, was very generally an object of observation, we give the Astronomer Royal's remarks in full: —

"The state of sky and of atmosphere was exceedingly favourable for observation of the lunar eclipse of last night. At the time of greatest obscuration, I carefully compared the light of the moon with that of several neighbouring stars. This I could do with considerable accuracy, by observing the objects with the eye unarmed, as my near-sightedness converts every object into a broad luminous disc, and there is no essential difference in the appearance of the moon and of a star, excepting in the quantity of light. In this manner I found that the light of the moon considerably exceeded that of *Antares*, sensibly exceeded that of *Spica*, and somewhat exceeded that of α *Ophiuchi*, but was a very little less than that of α *Aquilæ*.

"It will be remarked that the moon's centre was 22′ distant from the centre of the shadow at the time of conjunction in R.A., so that the moon was not very deeply plunged in the umbra. Had the eclipse been central, the light would have been much less."

We have to notice briefly the following papers, communicated at the meetings of November, December, and January; to which our limited space prevents our making a more lengthened reference :—

F. Abbott, Esq., communicated some observations on the variable star η *Argus*. This same η Argus has been an object of scrutiny by other astronomers, and to whom it has caused some perplexity, and, amongst others, by Sir John Herschel, when at the Cape, with an 18-inch reflector. On that occasion, Sir John wrote in the following terms :—"No part of this Nebula shows any sign of resolution into stars." The form of the Nebula amongst which the star was situated is, as our readers are aware, figured in the 'Outlines of Astronomy' in the shape of a dumb-bell, the star appearing of the first magnitude, and situated in its most dense part. It now seems that, although the star is in the dark space, out of the Nebula, which has altered in form, it only appears as a body of the sixth magnitude. These changes, both in Nebula and star, have taken place between 1838, the date of Sir John's observations, and last year, when Mr. Abbott examined it. The author suggests that the variability of the star might be occasioned by the interference of the nebulosity surrounding it.

A letter was read from Mr. Higgens, addressed to Admiral Smyth,

in which the writer forwarded some notes on the two component stars of 95 *Herculis*. The instruments used were a $3\frac{1}{4}$-inch acromatic with 80, and a 4-inch with 115: both by Cooke of York. Mr. Higgens observed these stars in April, May, and August last, and witnessed some remarkable changes in their apparent colour. From the fact of both stars appearing to change their colour simultaneously, the Astronomer Royal thought it implied some possible change in the telescope.

Capt. Noble, and C. L. Prince, Esq., communicated their observations of Venus at the Inferior Conjunction; the latter gentleman also his observations of the occultation of κ *Cancri* by the Moon, on the 26th April 1863.

Sir A. Lang sent some observations made in the Island of St. Croix, at the rising of the sun, with a view to determine the Refraction: also, some notes on remarkable sun-spots in 1862–63.

The elements of the new Minor Planet (79), 10th magnitude, discovered by Mr. Watson, Director of the Ann Arbour Observatory, were also given.

An extract from a letter to Mr. De La Rue, from Dr. Winnecke, was read, which went to show the probability of the variableness of light of some of the feebler stars about the neighbourhood of the Trapezium in the great Nebula of Orion.

The translation of a paper by P. A. Hansen, "*Calculation of the Sun's Parallax from the Lunar Theory*," was communicated by Mr. Airy. The result gave 8."9159 as the Parallax.

Results of the meridional observations of small Planets, *Angelina* (64) and *Cybele* (65); also occultation of stars by the Moon; and Phenomena of Jupiter's satellites; made at the Royal Observatory, were given by the Astronomer Royal.

New Elements of *Leto* (68) were communicated by Dr. Luther, of Berlin

The Elements and Ephemeris of Comet IV, and notes of observations of Comet IV and V, 1863, by H. Romberg, were communicated by J. G. Barclay, Esq., at whose observatory they were made.

Mr. E. J. Stone presented a paper, "*On the Motion of the Solar System in Space*," forming a supplement to one on the same subject read by the Astronomer Royal, at the meeting, March 11, 1859.

"*On the Eclipses recorded in the Ancient Chinese Historical Work called Chun Tsew*," is the title of a paper by the Assistant Secretary, J. Williams, Esq. "The Chun Tsew," writes Mr. Williams, "is said to be the only work really written by Kung Foo Tze, or, as we call him, Confucius; the other treatises attributed to him having been compiled by his disciples, either during his lifetime, or, as in the last of them, some years after his death. It treats of the history of Le Kwo, or Confederated Nations, into which China was divided during the during the Chow Dynasty, *viz.* between 1122 and 255 B. C."

"The period of this history is from 722 to 479 B. C., being an interval of about 242 years, during the latter part of which Confucius flourished." . . . "The account of each eclipse is but little more than a brief mention of its occurrence at a certain time."

Mr. Williams presents us with a specimen as follows:—"In the fifty-eighth year of the thirty-second cycle, in the fifty-first year of the Emperor King Wang, of the Chow Dynasty, the third year of Yin Kung, Prince of Loo, in the spring, the second moon, on the day called then Tsze, there was an eclipse of the sun." This date answers to 720 B. C.

A complete list of all such eclipses, with the year B. C., and month and day answering to the Chinese dates, is added. The days have been computed by Ideler's method, but Mr. Williams warns his readers that they must only be considered as approximate.

Mr. E. J. Stone presented a Memoir, entitled "*Proper Motions of the Stars of the Greenwich Seven-year Catalogue of* 2,022 *Stars for* 1860, *not included in the Greenwich Twelve and Six-year Catalogues, deduced by Comparison with the Results of Bradley's Observations, as given in Bessel's Fundamenta Astronomiæ.*" This Memoir forms a continuation to those by Mr. Main.*

J. R. Hind, Esq., communicated a note, "*On the Variable Nebula in Taurus;*" in which he records that, on the 12th of December, no trace of the Nebula could be seen either by himself or Assistant, although the atmosphere was in a most favourable condition for Astronomical observation.

M. G. de Pontécoulant communicated a paper "*Sur le Coefficient de l'Equation Parallactique déduit de la Théorie,*" suggested by some notes by Mr. Stone and M. Hansen in a former volume of the "Notices." The paper did not present any point of general practical interest.

At the November meeting, M. Léon Foucault, M. Knowalski, M. Winnecke, and Prof. G. P. Bond, were duly elected Associates of the Society. With one or two unimportant omissions, we think we have here communicated to our readers the pith of the proceedings of the Royal Astronomical Society.

THE CHEMICAL SOCIETY.

Up to the present time, the proceedings of the Chemical Society, during this quarter, have been destitute of any especial interest. The law of the absorption of mixed gases in water has become an important subject of inquiry since Bunsen has proposed absorption as a method of analysis. A promising chemist, Mr. W. M. Watts, has experimented with mixtures of ammonia and hydrogen, and of sulphurous and carbonic acid, principally with the view of testing the truth of Dalton's conclusion, that each gas is retained in water by the pressure of gas of its own kind; no other gas with which it may be mixed having any permanent influence in this respect. The results of Mr. Watts' experiments have led him to the conclusion that the proportion of mixed gases absorbed is not in accordance with Dalton's simple law.

* See vols. xix. and xxviii. of the Transactions of the Society.

XUM

A contribution to physiological chemistry, on the vexed question of the colouring matter of urine, was communicated by Dr. Thudichum, who believes that he has isolated both the pigmentary and odorous principles of this secretion. The former body he designates *urochrome*, the latter, *otto of urine*. In the absence of any analysis of these bodies, and without an exact knowledge of the manner in which they are to be obtained, the question, "What is the colouring matter of the renal secretion?" may be still considered open, unless, with Dr. Harley, we believe it to have been settled by Scherer. This distinguished chemist and physiologist succeeded in isolating a red matter, to which he gave the name of *urohæmatin*, since it presented a close analogy to the colouring matter of the blood, by containing an appreciable amount of iron. Scherer considered the body to result from this disorganization of the blood corpuscles, the waste of which was eliminated from the system in this form. This is an ingenious theory, and the question deserves further examination. Dr. Thudichum finds the merest trace of iron in his urochrome; but we must wait for a more complete account of the author's researches.

The formation of new bodies, by the abstraction from other bodies of certain elements or molecules of elements, and substituting for these certain other elements or groups of elements, the resulting compounds having well-defined and characteristic individualities; and further than this, the production of natural from artificial substances (like the formation of tartaric acid from dibromosuccinic, by Mr. Perkin), by successive substitutions, may rank among the greatest triumphs of human ingenuity. Perhaps the most prolific parent of artificial bases has been Dr. Hofmann, whose skill in effecting the transformations is only equalled by the lucidity with which he explains them.

Apropos to a paper on Acetanilide, by Mr. C. G. Williams, the Chemical Society recently heard from Dr. Hofmann a short account of a series of new creations, obtained by the action of chloroform on aniline, and of pentachloride of phosphorus on a mixture of aniline and acetanilide—the first of an infinite series of bodies which may be produced by similar reactions on similarly-constituted substances. The names of these new bodies, diphenyl-formyl-diamine, and diphenyl-acyl-diamine, show them to be of interest only to advanced chemists. New instances of conversion were brought forward at the same meeting, malic acid having been converted into malonic, and propionic acid into succinic, by Kolbe and by Muller.

The question, "What is the best form in which nitrogen and phosphorus can be applied as manure to plants?" has engaged the attention of many minds; but perhaps the most original experiments made on the subject, have been those of M. Ville, recently described to the Chemical Society by Dr. Hofmann. M. Ville has, however, come to the conclusion that none of the compounds of phosphorus and nitrogen answer better than those in common use—phosphoric acid and ammonia. It will be of interest to farmers who study chemistry, to learn that ethylamine and methylamine seemed to produce no better results than their prototype ammonia.

At the meeting on March 3rd, a very interesting paper on the non-metallic impurities in Refined Copper, by Mr. Abel, was read. The metallic impurities in copper had been fully treated of in previous contributions by the same author. The impurities mentioned in the present paper are Oxygen, Sulphur, and Selenium. Oxygen exists in copper in the form of a suboxide of the metal, which is soluble in the fused copper. The exact quantitative determination of the oxygen was a matter of extreme difficulty, but the process now given by Mr. Abel makes it a comparatively simple matter. Pure copper decomposes nitrate of silver, the latter metal being deposited, and a corresponding amount of nitrate of copper being formed. When, however, suboxide of copper is present a subsidiary action takes place, and insoluble basic nitrate of copper is formed. The author, therefore, converts a known weight of the copper into nitrate by digesting with a neutral solution of nitrate of silver, collects and washes the silver and basic nitrate of copper on a filter, and subsequently digests with a known volume of weak standard sulphuric acid (one part to a hundred of water) to dissolve the basic nitrate of copper formed. The proportion of sulphuric acid neutralized in this operation is ascertained by means of a standard solution of carbonate of soda, and the amount of oxygen or suboxide of copper is calculated therefrom. In the course of these experiments it was noticed that the physical structure of the metal afforded some indication of the amount of oxygen. Ingots which exhibited depressions on the upper surface were invariably found to contain more oxygen than those which were flat. The amount of oxygen present in Kapunda copper, we may add, was found to vary from ·12 to ·33 per cent. In Swansea copper in different stages of manufacture, Mr. Abel found the amount of oxygen to vary from 0·42 per cent. in "Dry" Copper, to 0·03 per cent. in "Over poled." While looking for carbon the author found selenium in copper, but in an excessively minute quantity, 0·003 per cent. It is worth mentioning that Mr. Abel could find no evidence of a combination of copper and carbon. Sulphur was found in very small quantity, but neither phosphorus nor nitrogen could be detected. Silicon might be present in a portion of inclosed slag, but not in combination with the metal.

At the same meeting a communication on the Synthesis of Leucic acid, was made by Dr. Frankland. Leucic acid has been obtained by the author synthetically, by the substitution of one atom of oxygen in oxalic acid, by two atoms of ethyl. This was effected by acting on oxalic ether with zinc ethyl.

THE GEOLOGICAL SOCIETY.

Since the Anniversary of last year some very important and interesting papers have been contributed to the Proceedings of this Society, most of them suggesting new interpretations of known facts, but some also referring to phenomena hitherto unknown or, at any rate, never before explained. The field over which the researches embodied in these various memoirs extends is a wide one, including as it does the following subjects:—(1) Breaks in the Succession of the British Palæozoic Strata; (2) Fossil Estheriæ; (3) Relation of the Permian Fauna and Flora to those of the Carboniferous Period; (4) Origin of the Parallel Roads of Glen Roy; (5) River-action; (6) Geology of the West Indian Islands; (7) The Abbeville Jaw and the associated Flint Implements; (8) Geology of the Eastern Archipelago, besides a number of other questions, of either more special or merely local interest.

1. The subject of the Anniversary Address of the President of the Society, Professor Ramsay, reminds every geologist how imperfect is our knowledge of the rock-formations which constitute the crust of the earth, the theme being "Breaks in the Succession of the British Palæozoic Strata." It is, moreover, one upon which no author has before written systematically, although many have described particular breaks incidentally when treating of other subjects.

"Breaks in Succession" are defined by Professor Ramsay to be "those physical interruptions in stratification marked by the unconformity of an upper formation to one immediately underlying it, or, when such visible unconformity is wanting, by a sudden change in the fossils characteristic of the underlying and overlying formations;" but he immediately afterwards introduces a necessary limitation, stating that he only applies his argument "to those cases in which the upper formation is next in time to that which underlies it, according to our present knowledge of the order of succession." Now these breaks are as good evidences of the lapse of time as a series of strata would be.

Before the publication of this address few geologists would have admitted the existence of as many as ten physical breaks, as above defined, in the primary rocks of Britain, yet Professor Ramsay, in a series of very lucid arguments, shows the existence of at least that number of gaps in our palæozoic series, and also that they are accompanied (except in one case, where the rocks are almost barren) by "great and remarkable changes in the number and nature of the fossils." He also discusses the questions arising out of a consideration of this coincidence, especially the old notion that entire faunas had been suddenly destroyed, and the theory of Professor E. Forbes (lately revived in another shape by Professor Huxley) respecting the contemporaneity of strata; together with Mr. Darwin's hypothesis of the origin of species, of which he appears to be a warm advocate.

The conclusion to which he arrives respecting the lapse of time represented by these breaks is rather startling; and although no geologist is better qualified than Professor Ramsay to judge of the value of such gaps, yet one cannot help thinking that he has somewhat

exaggerated their importance. However, we give this conclusion in his own words:—

"Believing that the causes that produced physical changes were much the same in former times as now, both in kind and intensity, (speaking generally, when spread over long epochs), *then the upheaving, contorting and dislocation of the strata, and the vast denudations they underwent before resubmergence, generally represent a period of time longer than that occupied respectively by the deposition of the formation disturbed, or of that which overlies it unconformably.*

"In the present state of our knowledge these things cannot be proved, but we may strongly suspect them to be probably true, and if they are so, then it follows that *the periods of time stratigraphically unrepresented during the Palæozoic epoch were much longer than those of which the various formations of that epoch bear witness.*"

2. A paper by Professor Rupert Jones on "Fossil *Estheriæ* and their Distribution" may be viewed as an abstract of, though differing somewhat in scope from, his "Monograph of the fossil Estheriæ" published by the Palæontographical Society. It is a very favourable specimen of philosophical palæontology, and shows that the diligent study of an apparently small subject may lead to large results.

Besides the endeavour to fix definitely the ages of the several deposits in which *Estheriæ* occur, by means of the little fossils themselves, assisted by concurrent testimony drawn from other sources, the chief object of the paper is to prove that the fossil *Estheriæ*, like their recent congeners, inhabited fresh and brackish water. The successful manner in which the author manages to dispose of apparently associated marine shells is not a little instructive, as it shows the necessity of scrupulously exact observations respecting the particular bed in which a fossil is found, most of these marine shells being shown to occur either a little above or a little below the *Estheriæ*; and the same with regard to crystals of salt. Even in the case of a *Lingula* occurring in the same bed as an *Estheria*, Professor Jones is at no loss, for he finds that the *Lingula* "in successive beds appears smaller and smaller in size, until it is dwarfed and disappearing, when *Estheria minuta* comes in; as if more and more fresh water invaded the area, unfavourably to the *Lingulæ* and ultimately bringing in the *Estheriæ*."

3. The relation of the Permian fauna and flora to those of the Carboniferous period has of late years been fruitful of discussion, most geologists being now inclined to regard the Permian as the concluding portion of the Carboniferous epoch.

In a paper on the Lower Carboniferous Brachiopoda of Nova Scotia, Mr. Davidson gives an excellent account of the present state of this question, and adds many new facts in favour of the view that the Permian is not really a group distinct from the Carboniferous.

Sir R. I. Murchison also enters somewhat fully into this question in a paper on the Permian rocks of Bohemia; but, were it not for the proverbial affection which every father bears towards his own children, it would be difficult to understand why this veteran geologist should so strenuously oppose a view which, besides being supported by nearly all the geologists and palæontologists who have specially studied the

subject, appears scarcely assailable by arguments drawn from stratigraphical details, but must be decided by means of the fossils.

4. The next paper especially worthy of notice, is that by Mr. Jamieson, on the "Origin of the Parallel Roads of Glen Roy," a question which, as everybody knows, has hitherto baffled, more or less, every attempt at its solution.

The view advocated by Mr. Jamieson was suggestively propounded by Agassiz many years ago, but has been until now almost ignored. According to this theory, the "parallel roads," or terraces, are the beaches of glacier-lakes; and Mr. Jamieson finds that it is the only one which will account for all the facts, and which is not inconsistent with collateral phenomena. He also brings forward some new facts in corroboration of Agassiz's theory, especially the coincidence between the heights of the lines and those of certain "cols" (the latter being, strictly speaking, a few feet the lower), and the evidences of glaciers having formerly blocked up the mouth of Glen Roy.

Now, the existence of a glacier-lake depends, firstly, upon that of a glacier damming up the mouth of the valley; and, secondly, upon there being no other outlet for the water.

The following may, therefore, be considered the sequence of events described by Mr. Jamieson:—

Glaciers from the Great Glen, Corry N'Eoin, Glen Treig, &c., blocked up the mouths of Glen Roy and Glen Spean, the last-mentioned glacier projecting into Glen Roy, and thus cutting off the connection of that valley with the "cols" just noticed; accordingly a glacier-lake was formed in Glen Roy, and the beach forming the uppermost line was deposited; the Glen Treig glacier then shrank so as to open out the higher col—that of Glen Glaster—thus causing the lowering of the level of the water in Glen Roy; and then the middle terrace, or road, was deposited; the Glen Treig glacier then shrank again, until it withdrew out of Glen Spean, and that valley being now clear, the water escaped at Makoul; then, at about the level of that outlet, the lowest terrace was deposited.

In a similar manner Mr. Jamieson accounts for the "roads" in certain smaller glens; and he also shows why some of them stop or are indistinct at certain points; and, altogether, his explanations are so simple and so natural that the inducement is very great to believe that this much-debated question is at last settled.

5. River-action is illustrated in a most interesting paper, by Mr. Fergusson, on "Recent Changes in the Delta of the Ganges," and also in another on the Nile, by Dr. Leith Adams. Mr. Fergusson begins by enunciating certain principles of river-action, the first of which is, "all rivers oscillate in curves, whose extent is directly proportionate to the quantity of water flowing through the rivers;" but a certain looseness in the author's mode of expression renders it necessary to be careful not to give a too literal interpretation to some of his sentences; for instance, in this particular case, he evidently means to say that this principle is true when *all other conditions are equal*, for shortly afterwards he observes, that the extent or radius of the curves (*cæteris paribus*, understood, as before) is "directly proportioned to the slope of

the bed of the river." After illustrating these propositions, he next discusses the tendency of rivers flowing in alluvial soils to raise their banks, and thus to confine themselves in their beds; and he explains the process by means of which this result is brought about somewhat differently from Sir Charles Lyell and other writers, as he calls in the aid of "backwaters," or large bodies of still water in the low lands beyond the banks of the river, the effect of their existence being that the overflowing water of the river is forced to deposit its silt as soon as it meets them, which is, in the wet season, soon after it leaves the river. In the particular case of the Ganges, Mr. Fergusson is doubtless right; but it is extremely hazardous to generalize from a solitary instance. The secular elevation of deltas, and many other interesting subjects, are then treated; and the author also describes in detail the principal changes that have taken place, during the historic period, in the delta of the Ganges; that is to say, the changes in the courses, directions, outlets, &c., of the various rivers, the alteration in the slope of their beds, and many other phenomena, all showing the magnitude of the results brought about by river-action, and the rapidity of the changes, as well as the mutual dependence of the different rivers of the same valley. Indeed, we may consider that in the Valley of the Ganges there is being played a natural game of chess on a gigantic scale; the valley itself is the chessboard, the rivers are the pieces, while the producers of the changes—water and mud—are the players. The effect of a move of any particular river in any direction in altering the relations of the rest, and the many other ways in which the connection of the various rivers is shown, together with the laws which regulate these changes, and river-action generally, are very curious, and deserve more attention from the geologist than they have hitherto received.

The chief object of Dr. Leith Adams's paper is to prove that the Nile has at a comparatively recent period flowed at a much higher level than it now does, at any rate north of the second cataract. The evidence upon which this conclusion rests consists chiefly of the occurrence of fluviatile shells at high levels. These shells were found in beds of alluvium forming terraces on the banks of the river, and they belong, according to Mr. S. P. Woodward, to six species, namely—*Unio lithophagus*, *Cyrena fluminalis*, *Ætheria semilunata* (Nile oysters), *Iridina Nilotica*, *Paludina bulimoides*, and *Bulimus pullus*. The first species is doubtful, the next four all live in the Nile at the present day, and the last probably occurs in the neighbourhood. They were found at all heights, up to *at least* 120 feet above the highest Nile of the present time.

Dr. Adams gives a sketch of the physical structure of the Nile Valley, and notices the collateral evidence in support of his conclusions to be derived from the position of ancient temples, tombs, and other monuments, striving to prove not only that the Nile above the second cataract formerly flowed at a much higher level than it now does, but also that the primæval river was much larger and more rapid than the Nile of the present day.

This paper is certainly an important contribution to the history of

the Nile; but it should not be forgotten, although it appears to have been almost lost sight of, that Russegger discovered fluviatile shells at high levels in the Nile Valley more than five-and-twenty years ago.

6. Much light has been thrown upon the geology of the West Indian Islands in two papers (or, rather, two parts of one paper) by Dr. Duncan "On the Fossil Corals of the West Indian Islands," and one by Mr. J. Carrick Moore "On some Tertiary Shells from Jamaica."

Many years ago Mr. Carrick Moore suggested that the separation of the Caribbean Sea from the Pacific Ocean was not so complete in early Tertiary times as it now is, and the chief result of the papers just mentioned is that they prove, almost to demonstration, that this separation was not complete until long after the commencement of the Tertiary period.

It may be useful to give a synopsis of this argument, as it is an extremely good specimen of the manner in which the palæontologist infers the character and the date of changes that have occurred on the surface of the earth in geological periods. In most of the West Indian Islands certain strata occur containing shells and corals which, at first sight, appear (especially the shells) to resemble those now living in the Caribbean Sea; but, when closely examined and compared, they are found to be nearly all distinct. Furthermore, a careful comparison of them with recent fossil species from different localities shows that, while many of them resemble or are identical with species found in the Miocene beds of Europe, others bear the same relation to forms now living in the Pacific Ocean, a very small proportion (especially of corals) being allied to, or identical with, Caribbean species. It therefore follows, granting the usual postulates of palæontology, that the deposits are approximately of the age of the Miocene beds of Europe, and that, at or about the time when the animals lived, the remains of which occur fossil in these strata, there was free communication between the Pacific Ocean and the Caribbean Sea.

Dr. Duncan also discusses many other interesting points, such as it can easily be understood the determination of no fewer than 76 species of fossil corals from such a region would suggest to the mind of a palæontologist; but it is here quite impossible to do more than draw attention to his valuable papers.

7. The Abbeville jaw and the associated flint implements have attracted so much attention, and the circumstances attending their discovery have already been so often explained, that a knowledge of them may be fairly assumed in discussing Mr. Prestwich's paper "On the Section at Moulin Quignon, Abbeville, and on the peculiar character of some of the flint implements recently discovered there." It is absolutely refreshing to read a paper in which the identical pit in which the jaw was found is described, but which contains merely a few passing allusions to that redoubted relic of, possibly, man's antiquity, but, much more probably, of his cupidity and deceitfulness.

The question of the authenticity of the jaw and of certain associated flint implements is as complicated as that of Schleswig-Holstein itself, and is still less likely ever to be satisfactorily settled. Even the author of this paper, one of our most competent observers, after devoting

several pages to the endeavour to prove the authenticity of the flint implements, appends a postscript to his communication for the purpose of stating that he is now convinced of their fraudulent nature,—an opinion, by-the-bye, which he originally held. So also Dr. Falconer and others have first been advocates of one view, then of the other, and sometimes have gone back again to their original opinion.

Setting aside the jaw and the flint implements, Mr. Prestwich's paper has an independent value, on account of the lucid discussion it contains respecting the manner in which the gravels of the Valley of the Somme were deposited. The author gives theoretical sections of the valley at the time of the formation, and at that of the emergence, of the high-level valley-gravels, as well as at the time of the formation of the lower-level valley-gravels, and an actual section of the valley at the present time; he thus shows that the high-level gravels are the older; that the valley has been chiefly formed by the river itself, from which also and from floating ice the gravels and loess were deposited; and that, whatever difference of opinion may exist respecting certain flint implements, others, the genuineness of which cannot be questioned, have been found *in situ* from time to time during the last fifteen years, in some of the oldest of the high-level gravels of the ancient Valley of the Somme.

8. The geology of the Eastern Archipelago is illustrated by three papers, two of which, namely, "On the Geology and Mineralogy of Borneo and the adjacent Islands," by M. de Groot, and "Notes to accompany some Fossils from Japan," by Captain Bullock, are merely explanatory notes sent with specimens, while the third—"On some Tertiary Mollusca from Mount Séla, in the Island of Japan," by Mr. H. M. Jenkins,—is a description of some of the specimens referred to in the first-named communication.

As Mr. Jenkins observes, Java has hitherto been a *terra incognita* to the geologist, and it is therefore interesting to have, at last, a definite age assigned to some of the Tertiary beds of that island, with the data before us upon which the conclusion rests. The author considers the fossils he describes to be of late Miocene date, though they have until now been considered Eocene, but not upon any very tangible grounds; he also discusses several questions arising out of a consideration of these Javan specimens, endeavouring to show that some portion of the so-called Nummulitic formation of India is also Miocene, in this view being supported by Dr. Duncan in a note on the Scindian fossil corals. He also advances the hypothesis, not without a certain amount of evidence in favour of it, that the Miocene fauna of the middle and south of Europe emigrated eastwards into the Indian Ocean. Basing his argument upon this view he strives to show that, with a representative fauna (on the principle enunciated by Professor E. Forbes), a series of Tertiary beds in the east would be newer than their apparant equivalents in Europe—a conclusion which is very important if it be true, but which at present requires confirmation; the same may also be said of the assertion that a tropical representative of the Pliocene formation of Europe could not be distinguished from a late Miocene formation.

Among the many meritorious papers of less general interest may be mentioned the following:—"On the Middle and Upper Lias of the Dorsetshire Coast," by Mr. E. C. H. Day; "On some Ichthyolites from New South Wales," by Sir P. G. Egerton; "On a Hyæna-den at Wookey Hole," by Mr. W. Boyd Dawkins; "On the Original Nature and Subsequent Alteration of Mica-schist," by Mr. H. C. Sorby; "On a new Species of *Dendrerpeton* and on the Dermal Coverings of certain Carboniferous Reptiles," by Dr. J. W. Dawson; "On the Upper Old Red Sandstone and Upper Devonian Rocks," by Mr. J. W. Salter; "On the Older Rocks of Bavaria and Bohemia," by Sir R. I. Murchison; "On the Skiddaw State Series," by Professor R. Harkness; with many others.

Judging from the number of new Fellows elected during the past year, the society must be in a very flourishing condition. We notice the following well-known names among those of the newly-elected Fellows:—Il Commendatore Devincenzi, Minister of Agriculture and Commerce of the Kingdom of Italy; Nicholas Kendall, Esq., M.P., Member of the Royal Commission of Mines; the Rev. Charles Kingsley, M.A., Professor of Modern History in the University of Cambridge; James Fergusson, Esq., F.R.S., author of the History of Modern Architecture, &c.; J. F. Iselin, Esq., M.A., Inspector of Science-Schools; E. J. Routh, Esq., M.A., Fellow of St. John's College, Cambridge.

A Class of foreign correspondents—to include not more than forty foreign geologists—has lately been instituted, and the lists of those already elected include the names of very many foreigners of note.

THE MICROSCOPICAL SOCIETY.

Dr. Lionel Beale has, during the past quarter, read before the members of this Society a paper of such great interest to physiologists, that we feel justified in devoting the chief portion of our limited space to an account of its leading features. It will no doubt be reported in detail in the 'Quarterly Journal,' devoted to the progress of Microscopical Science.

In continuation of his reports on this and kindred subjects, Dr. Beale communicated a very valuable paper on the Germinal Matter of the Blood, with remarks upon the formation of Fibrin. The author described all germinal matter as being soft or semifluid, and always of the spherical form, unless otherwise distorted by external agency. White blood-corpuscles, and the numerous small colourless corpuscles which Dr. Beale described in a former paper to the Society, consisting principally of living or germinal matter, are of a spherical form. In the blood of man and the higher animals, and we may add in the fluids of nearly all Invertebrata also, there exist a great number of these minute granular particles, of the same general appearance and refractive power as the matter of which the white blood-corpuscles are

composed. It has been shown that both the red and white corpuscles of the blood vary very considerably in size; and Dr. Beale has satisfied himself that some, if not all the minute granular particles described by him, grow into white and red corpuscles. He also sees no reason why corpuscles may not exist in the blood, of such a size as to be actually invisible to the human eye, even when assisted with the powerful adjunct of a $\frac{1}{25}$th objective. The granular particles absorb nutriment from the medium in which they float, and undergo numerous subdivisons, producing other similar granules destined to become blood-corpuscles. The motive power which enables the granules thus to subdivide, has no connection with the nucleus or nuclear matter, but resides solely in the so-called "basis-substance," which is the semi-transparent matter forming the mass of the cell. This "basis-substance" is not a simple fluid, but consists of very minute, colourless particles, free to move upon each other; and Dr. Beale believes this motive-power to be an inherent and peculiar property of living matter. In cases of inflammation, as, for instance, where the capillaries in the foot of the Frog are thus affected, the germinal matter is more able to absorb nutrient substance on account of the retarded circulation. Hence it is that white corpuscles are so abundant in vessels subjected to inflammatory action, masses of clot having been observed, which consist of little else but white corpuscles. The author, however, does not consider that this development from granules of germinal matter is the only mode in which white blood-corpuscles are formed. In the development of the blood-vessels, the general opinion is that cells become stellate, and that the processes formed by the contiguous cells meet together; and thus, it is conceived, the cavities of the adjacent cells become connected together by tubes. Dr. Beale has already contested this inference and endeavoured to show that, so far from any coalescence between cells taking place, the communicating tubes, which are, of course, the incipient blood-vessels, are formed by the separation or moving away from each other of "cells" which were originally contiguous. The walls of the tubes thus formed contain germinal matter, which is supposed to be not unfrequently detached in small masses, thus giving rise to small corpuscles of a similar nature to that of the white corpuscles. The increase of the production of white corpuscles is favoured in all conditions in which the access of pabulum to these masses of germinal or lining matter is increased. In connection with this view of the production of blood-corpuscles, Dr. Beale has been led to a theory of the origin of exudations, which differs both from that held by those who support the "exudation theory," and those who uphold the "cell theory." He considers that portions of the granular bodies in the blood may pass through the walls of capillary vessels, and then being surrounded by a suitable pabulum, increase and multiply by subdivision, producing sometimes clear fluids, at other times viscid, corpusculated masses.

The question of the coagulation of the blood, which has been so much and so variously agitated of late, is also touched upon by the author. When discussing the anatomy of the red blood-corpuscles

in a former paper he endeavoured to show that the coloured matter bears to the colourless or living germinal matter the same relation as formed material in other cases bears to germinal matter. It is formed from it, or rather results from changes occurring in it. If the living or germinal matter die, slowly and naturally (as when in the circulating fluid of the body), the red colouring matter is one of the substances resulting from its death. Numerous facts render it almost certain that these and other masses of germinal matter give rise to different substances, according to the conditions under which the particles cease to exhibit vital phenomena. The production of the material we know as fibrin is due to the death of minute particles of the living matter of the white and small colourless corpuscles, which takes place, under ordinary circumstances, when blood escapes from the vessels of the living body; in fact it is one of the consequences of the first decomposition which the blood undergoes after death. Such decomposition may occur, under certain circumstances, in the body itself. The action of ammonia on the blood, after death, is considered by Dr. Beale to be such as to keep the fibrin once produced in a state of diffusion throughout the mass; but he by no means considers its presence in the living blood as demonstrated, regarding, as he does, the theory he has propounded sufficient to account for the phenomena of coagulation without its interpolation. Neither is Dr. Beale at all inclined to assent to the views of Professor Lister, whose researches he, however, mentions with great deference. The theory propounded by that gentleman, that living substances, such as the walls of blood-vessels, &c., have not the power of separating fibrin from the blood, while external matters of an inanimate nature possess that property, is, he observes, unwarranted by our present knowledge, such an assertion as to the properties of living and inert bodies being as yet unsupported by conclusive proof. At the conclusion of his paper Dr. Beale remarked upon the unfairness displayed by those engaged in writing reviews upon the works of observers in this country—who, he says, are too wont to dwell upon the observations of foreign investigators to the neglect of those of their own countrymen.

Dr. Lauder, of the Royal Navy, has communicated a paper on Marine Diatomaceæ found at Hong-Kong, with descriptions of new species. The species described belong to the genus Chætoceros—and are very abundant in the harbour of Hong-Kong. Several species are enumerated.

Mr. D. E. Goddard has described a new form of mounting-table. It consists of a piece of brass 12 inches long and 3 inches broad and 1⅛th of an inch thick, a large space is punched out in the centre of the usual form of microscope slides. The table is supported by four legs, and a spirit-lamp can be placed beneath, thus enabling the operator conveniently to moderate the amount of heat used. The table is likely to be much employed by those who indulge in such accessory apparatus, though it cannot be said to be a necessary or even an important piece of mechanism.

THE ROYAL SOCIETY.

THE papers read before the Royal Society during the past quarter have been of their usual varied character. They embrace the whole circle of the sciences, but the communications to which we shall chiefly allude in these pages are those relating to natural and physical science. Among these we find one of a very abstract nature, "On the Condition, Extent, and Realization of a Perfectly Musical Scale on Instruments with Fixed Tones," by Mr. Ellis. It was a very recondite paper, which could only be made intelligible to those profoundly acquainted with the science of music and by the help of extended diagrams.

Chemists have taken but a small share in the proceedings of the Royal Society this quarter. Dr. Stenhouse contributed a short paper on Rubia munjista or the Madder of the East Indies, in continuation of a paper communicated to the Society last year. Among the new facts contained in this paper was the analysis of the colouring principle of East India madder, to which Dr. Stenhouse has given the name of *Munjistine*. He found it to be closely allied in composition to the colouring matters obtained from Turkey, and Continental madders. Munjistine, though existing in larger quantity in Munjeet, than Alizarine in the best Naples madder, has unfortunately much less tinctorial power, and consequently the value of East India madder as a dye stuff is much smaller than that of either Turkey or Naples. From the purpurine of munjeet Dr. Stenhouse has produced a new dye, by dissolving it in ammonia, and allowing the solution to rest in a warm place for about a month, occasionally replacing the ammonia and water lost by evaporation. The purpurine disappears, and a new colouring matter is formed which dyes unmordanted silk and wool of a fine rose colour, but will not dye even mordanted vegetable fibre. The author gives the name *purpureine* to this new dye.

A paper of great scientific interest on the Acids of the Lactic series was communicated by Messrs. Frankland and Duppa.

Terrestrial magnetism now attracts a large share of attention, and the results of the observations made will some day lead to important consequences. At present we must reckon among the curiosities of science, the mysterious connection which seems to exist between the magnetism of our earth and the spots on the sun. Dr. Wolf, of Zurich, has gone over a table of the magnetic variations observed at Greenwich for several years, and compared it with his own observations of sun-spots, finding the years which show the greatest magnetic deviations to have been richest in sun spots.

The beautiful self-recording magnetographs at Kew have been adopted in the Observatory at Lisbon, and Señor Capello, of the Lisbon, and Mr. Stewart of the Kew, Observatories, now send to the Royal Society the results of a comparison of certain traces produced simultaneously at the two places, during the magnetic disturbances in July last year. It seems that when the Kew and Lisbon curves are compared together, a very striking similarity is found to exist between the horizontal force, one perhaps less striking between the declination

curves, and very little likeness between the vertical-force curves. The curves of vertical force are indeed nearly quite dissimilar. The peaks and hollows of the Kew curves were generally (simultaneously) reproduced at Lisbon, but in an opposite direction, a sudden augmentation of the vertical force at Kew corresponding to a diminution at Lisbon, and *vice versâ*.

When Captain Maguire was at Point Barrow during the winters 1852-53 and 1853-54, he made hourly observations of the magnetic declination. Similar observations were made by Captain (now Sir Leopold) M'Clintock, at Port Kennedy, 1,200 miles distant from Point Barrow, during the winter 1858-59. The learned President of the Royal Society, who may be considered the parent of this branch of science, has compared the results of these two series of observations in a paper communicated to the Society. The first point established is that the action of any disturbing force on the declination-magnet is less at Port Kennedy than at Point Barrow, that is, less at the station nearest to the points of 90° dip. The indication accords with the fact of the greater frequency of the aurora at Point Barrow. A remarkable correspondence is pointed out between the maxima of easterly and westerly deflection observed at the two stations. The maximum of easterly deflection occurred at the same hour of *absolute* time, the maximum of westerly at the same hour of *local* time. At Port Kennedy the normal direction of the magnet is 35° east of south: at Point Barrow 41° to the west of north: the contrast at the two stations is therefore nearly as great as can exist in any part of the globe, wanting only 6° of 180°, or of being diametrically opposite.

A few anatomical papers have been communicated during the past quarter. Mr. R. Lee contributed a paper on the Distribution of the Nerves in an Anencephalous Fœtus which he dissected, and in which he found the distribution quite normal. Professor Huxley made a communication on the Osteology of the genus Glyptodon. Mr. J. W. Hulke sent a contribution on the Minute Anatomy of the Retina of the Amphibia and Reptiles.

The last consisted of descriptions of the intimate structure of the retina of the Frog, Black and Yellow Salamander, Turtle, Land and Water Tortoises, Spanish Gecko, Blindworm, and Common Snake. In all seven layers are recognizable. Reckoning from the outer or choroidal surface of the retina these are: the Bacillary, the Layer of Outer Granules, the Inter-granular Layer, the Layer of Inner Granules, the Granular or Grey-nervous Layer, the Ganglionic Layer, and that of the optic nerve-fibres. The elements of the Bacillary Layer are remarkable for their large size, they are the bodies known as the Rods, and the Cones or Bulbs. There are good grounds for believing them to be the percipient elements. They consist of two segments, an outer or shaft, and an inner or body, the junction of which is marked by a bright transverse line. The shaft is a long rectangle in the rods; smaller and slightly conical in the lines. The body is flask or spindle shaped, and mostly smaller than the shaft in the Rods; more decidedly flask-shaped and larger than the shaft in the Cones. One of the "Outer Granules" is always associated with the

inner end of the body in both Rods and Cones, and may be regarded as an integral part of it; the number of "Outer Granules" consequently equals that of the Rods and Cones. These "Granules" are large circular cells, mostly containing a central nucleus in which they differ from the "Inner Granules." A very delicate fibre runs inwards from the inner end of the Rod and Cone body, not from the Outer Granule enclosed in this, as some think. This Mr. Hulke has traced through the intermediate layers to the inner part of the Granular Layer in the neighbourhood of the Ganglion cells. The "Inner Granules" are round or polygonal cells, more numerous than the "Outer Granules." The Ganglion cells are mostly multipolar; some of their processes join those of neighbouring cells, others join the bundles of optic nerve-fibres, and a third set bend outwards into the Granular Layer. In the Frog and Gecko Mr. Hulke has traced optic nerve-fibres passing outwards through Ganglionic into the Granular Layer. The author prefers the term Granular to that of Grey-nervous for the broad layer which lies between the Ganglionic Layer and that of the Inner Granules, as it correctly describes its appearance under a low power, and has no respect to the nature of the tissue, which he regards as connective and not nervous. A high power demonstrates a closely-woven web in part derived from the fibres traversing it in a radial direction discovered by Müller. The Inter-granular Layer he also regards as a looser web of coarser connective tissue. The orderly arrangement of the respective layers and of the cell-elements in each is maintained by a framework of connective tissue, which consist of a homogeneous membrane bounding the inner surface of the retina; of the system of fibres discovered by Müller, arising from the outer surface of this membrane and traversing all the layers in a radial direction to end upon the inner surface of a fenestrated homogeneous membrane, which receives the Rod and line-bodies; and lastly, of a delicate web in connection with these fibres, which preserves the disposition of the cells when in the several layers. These radial fibres are not looked on by the author as the link between the Rods and Cones, the percipient, and the optic nerve-fibres, the conducting elements of the retina: the view held by Müller, Kölliker, and some others. The true link he considers to be the fibre passing inwards from the inner end of the Rod- and Cone-body, which also has a radial direction, but is to be distinguished from Müllers' fibre.

Another paper of mixed chemical, physiological and optical interest was communicated by Professor Stokes. It has been supposed that biliverdin, the green colouring matter of bile, and chlorophyll, the green colouring matter of plants, are identical. An optico-chemical analysis of these bodies, however, shows them to be perfectly distinct. Chlorophyll is a compound body—a mixture of four substances—two yellow and two green, all possessing distinctive optical properties. It is extremely difficult to separate these bodies by chemical means, but they may be obtained in approximate state of purity. The phyllocyanine and phylloxanthine of Frémy, Professor Stokes shows to be what we may call products of decomposition.

A very valuable account of some Experiments made to determine

the effects of impact, vibratory action, and a long-continued change of load on wrought-iron girders was contributed to the Royal Society by Dr. Fairbairn. The experiments were undertaken in order to ascertain the extent to which a bridge or girder of wrought iron may be strained without injury to its ultimate powers of resistance, or the exact amount of load to which a bridge may be subjected without endangering its safety.

To give tables of the experiments would occupy too much space, but we may give the results arrived at. It follows from them that wrought-iron girders of ordinary construction are not safe when submitted to violent disturbances equivalent to *one-third* the weight that would break them. They, however, exhibit wonderful tenacity when subjected to the same treatment with *one-fourth* the load; and assuming that an iron-girder bridge will bear with this load 12,000,000 changes without injury, it is clear that it would require 328 years at the rate of 100 changes a day before its security was affected. It would, however, Dr. Fairbairn adds, be dangerous to risk a load of *one-third* the breaking weight upon bridges of this description, as according to the last experiment, the beam broke with 313,000 changes; or a period of eight years, at the same rate as before would be sufficient to break it. But the same beam had before been submitted to 3,000,000 changes with one-fourth the load, and it might be that during these experiments it had undergone a gradual deterioration which must some time, however remote, have terminated in fracture.

The girder experimented on, we may add, was a wrought-iron plate beam of the ordinary form, having a sectional top area nearly double that of the bottom.

An abstract of an abstract would give a very imperfect notion of the ideas propounded by the Rev. Joseph Bayma "On Molecular Mechanics," a new science, by which the author proposes to solve, "a problem which includes all branches of physics, and which may be enunciated in general terms, as follows:—

"From the knowledge we gain of certain properties of natural substances by observation and experiment, *to determine the intrinsic constitution of these bodies, and the laws according to which they ought to act, and be acted upon in any hypothesis whatever.*" There is no explaining a science like that of "Molecular Mechanics," as succinctly as Mme. De Stael once requested some German philosopher to explain his system—"*Dites-moi votre système dans un mot.*" We must wait for the author's volumes.

Two short papers, one by Mr. Prestwich "On some further Evidence bearing on the Excavation of the Valley of the Somme by River Action;" and another by the Rev. S. Haughton, "On the Joint System of Ireland and Cornwall," make up the geological contributions to the Royal Society during the first two months of the present year.

THE ROYAL INSTITUTION OF GREAT BRITAIN.

The scientific lectures at the Royal Institution have been of varied interest. In the first, on January 22, Mr. Grove, Q.C., gave an account of those curious experiments "On Boiling Water," which are now well known to all scientific men. Mr. Grove's experiments are confessedly but a continuation of those of M. Donny, of Brussels, who found that when water has been deprived of air, it no longer boils in the ordinary sense of that word, but exhibits the singular phenomenon of an occasional burst of vapour, the water in the intervals attaining a temperature higher than 212° Fahr. The principal result of Mr. Grove's investigations goes to prove the almost absolute impossibility of depriving water of all air; for however long, and under whatever conditions, water is submitted to heat, there is still found in it a very minute proportion of nitrogen. The lecturer hinted at some possible chemical connection between nitrogen and water, the preponderating substances on the surface of our planet, and the possibility of nitrogen not being merely the inert diluent it is commonly supposed.

Simple boiling, in the sense of a liquid expanded by heat into its vapour without being decomposed or having permanent gas eliminated from it, the lecturer believed to be unknown. Boiling (ebullition), therefore, is not the result of merely raising a liquid to a given temperature, but something much more complex.

To describe the experiments of Mr. Grove would occupy too much space, and we can only indicate the results, which went to show that chemical purity is a thing almost unattainable, and that in nature everything can be found in anything if carefully sought. Bromine when boiled, however long, always yielded oxygen; phosphorus invariably gave phosphuretted hydrogen; and sulphur, sulphuretted hydrogen, probably from the decomposition of water contained, which might lead to the supposition that a minute portion of oxygen, hydrogen, or of water is inseparable from these substances, and if boiled to absolute dryness, a minute portion of the gas would be left for each ebullition.

Mr. Grove further alluded to the effects of intense heat on simple and compound bodies, showing how the latter are decomposed, and the former undergo some molecular change, as phosphorus into its allotropic condition and oxygen into ozone. These facts showed that the effects of heat are not so simple as commonly supposed. In by far the greater number of cases, possibly in all, it is not mere expansion into vapour which is produced, but there is further a chemical or molecular change.

As regards the phenomenon of ebullition, Mr. Grove believes that no one has seen this take place without permanent gas being liberated, and that what is termed boiling arises from the extrication of a bubble of permanent gas, either by chemical decomposition of the liquid, or by the separation of some gas associated in minute quantity with the liquid, and from which human means have hitherto failed to purge it.

[These experiments of Mr. Grove probably explain the difficulty which working engineers have noticed of getting up steam with surface condensed water, and suggest the aeration of such water before it is again passed into the boiler. Mr. Grove asserts that water exposed to air takes it up as a sponge does water; but under some circumstances it may not absorb enough to produce steady ebullition.]

On January 29, Dr. Frankland lectured on the Glacial Epoch. As, however, this discourse will be treated at length in our Geological Chronicle, we shall content ourselves with a brief sketch of Dr. Frankland's physical theory. All our readers are acquainted with the evidences of glacier action on the surface of our earth, and the various hypotheses upon which the formation of glaciers has been explained. Dr. Frankland advanced a new theory, and conjectures that the sole cause of the phenomena of the glacial epoch was a higher temperature of the ocean, than that which obtains at present. Since the earth appears to be slowly cooling, it is conceivable that there was a time (not geologically distant) when the waters of the ocean existed in the atmosphere as aqueous vapour, as it may in Jupiter and Venus at the present day. After the formation of the ocean, the lecturer showed that the land must have cooled more rapidly than the sea. At this part of the subject, he alluded to some unpublished experiments of Dr. Tyndall, which prove the extraordinary intranscalency of aqueous vapour to rays of heat issuing from water. He showed also the comparative facility with which radiant heat passes from granite through most air. Thus we have a state of things tending much more to the conservation of the heat of the water, than to the retention of that of the land; and therefore, while the ocean retained a temperature considerably higher than at present, the mountainous regions of the earth had undergone a considerably greater refrigeration. The evaporation from the ocean would, therefore, have been greater than at present, and this increased evaporation must have been attended by increased precipitation, which would suffice to supply the higher portions of the land with that gigantic ice-burthen, which groaned down the mountain slopes during the glacial epoch. But as the oceanic temperature was higher, why was not the atmosphere warmer at greater elevations, and the snow-line raised? In answering this question, Dr. Frankland showed that the height of the snow-line essentially depends upon the amount of precipitation and accumulation of snow during the cold season, and not upon mean temperature. The mean temperature of land under extensive surfaces of snow must have been reduced, notwithstanding that the amount of heat in activity on the surface of the earth was greater during the glacial epoch than at present. The course of events, therefore, must have been as follows:—Whilst the ocean maintained a high temperature, the snow-line floated above the summits of the mountains; but with the reduction of the oceanic temperature it gradually descended, enveloping peak after peak, until, during the glacial epoch, it attained its lowest depression, whence it again rose, owing to diminished evaporation, to its present position.

On February 12, Dr. Wanklyn delivered a lecture "On the Synthesis of Organic Bodies," giving a brief account of the labours of Wöhler,

Pelouze, Kolbe, and Berthelot, in this most promising and interesting department of chemical research.

On the 18th, Mr. Savory lectured "On Dreaming and Somnambulism in their relation to the Functions of certain Nerve Centres." The actions of the body are variously classed as excito-motor, sensori-motor, and ideo-motor, the nerve centres employed in these actions being particular parts of the brain. Sleep is to the brain what rest is to the other parts of the body, and dreams result from the imperfect exercise of the hemispheres when only in a state of partial repose. Somnambulism results from the activity of the sensorium while the hemispheres are at rest. Dreaming is more common than somnambulism, because the cerebral lobes are most liable to variation from the quantity and quality of blood supplied to them, and from the influence of stimulants, narcotics, &c. In profound sleep no actions but excito-motor, or involuntary, such as the movements of respiration and of the heart, are performed; and these are reduced in force and frequency. In dreaming, ideas are aroused, and impressions either subjective or objective are produced. If the latter, it shows that the sensorium must be in partial activity. In somnambulism, the actions are sensori-motory, and the sensorium is in full activity. The above is the merest outline of a very eloquent lecture, which was concluded by some observations on the beneficial moral effects that may possibly be derived from a study of our dreams. They may in fact become the means of showing us what we really are.

On February 26, Mr. Prestwich lectured "On the Quaternary Flint Implements of Abbeville, Amiens, Hoxne, &c.; their Geological Position and History." In his address (fully reported in our Geological Chronicle), the lecturer says he is convinced that the flint implements are the genuine work of man's hands, and that their being found along with the remains of extinct animals, necessitates bringing the date of these animals forward, as much as carrying back that of man. He believes we have no data to decide definitely on the age of these remains; but thinks we are not warranted in assuming the length of time alleged.

The interesting and important lecture of Professor Stokes, upon the "Discrimination of Organic Bodies by their Optical Properties," must for the present be postponed.

THE ZOOLOGICAL SOCIETY.

One of the most interesting papers communicated to this Society during this session, was by Mr Alfred Newton, on the discovery of a mummy of the Great Auk (*Alca impennis*), in Funk or Penguin Island, 170 miles north of St. John's, Newfoundland. It appears that ever since the publication of Mr. Yarrell's 'History of British Birds,' containing his account of the Alca impennis, wherein was cited M. Audubon's statement that that species bred on an island in the neighbourhood of Newfoundland, the attention of British ornithologists has been directed to that colony, in the hope of obtaining thence specimens of this rare and curious bird. The Great Auk was known to the sailors engaged in the Newfoundland cod fisheries, as the Penguin, so far back as the year 1670, and the few that have been seen within the last sixty years or so, are spoken of as "Penguins." A Mr. Wolley had ascertained these facts, and feeling convinced that specimens of the bird were yet to be obtained, determined to work out its history. Meanwhile Professor Steenstrup published (Videnskabelige Meddelelser, 1855, pp. 33–116) an account of the Alca impennis, in connection with the discovery of its bones in great abundance on Funk or Penguin Island, by Herr Stuvitz. The author of the paper, Mr. Newton, feeling great confidence in Herr Stuvitz's statements, immediately set about corresponding with every one he could hear of in Newfoundland likely to assist him in obtaining any of these much-prized remains of the Great Auk. At last, after considerable delay, by the conjoint labours of the Rev. Reginald Johnson, of Fogo, and the Bishop of Newfoundland, Mr. Newton has succeeded in inducing Mr. N. R. Vail, a gentleman of scientific taste, to make application to Mr. Glindon, who is removing the soil from Penguin Island, on account of its containing large quantities of phosphatic manure, and who has ordered his men there employed to use their best endeavours to obtain the bones of the Penguin. Amongst numerous other remains, the mummy was found which Mr. Newton exhibited. It seems to have been deeply buried, being, says the Bishop of Newfoundland, "four feet below the surface, and under two feet of ice." The skeleton is not quite perfect; but when it is remembered what a rarity any bones of the bird are, *and that the nearest approach to a perfect skeleton of the Great* Auk, *viz.* that in the Jardin des Plantes, is wanting in many respects, the importance of Mr. Newton's discovery will be appreciated. Besides the skeleton in the Jardin des Plantes, there are two specimens of this bird in the Museum at Copenhagen—dissected with a view to show the various organs. In many museums specimens of bones from various parts of the body exist—as at Christiania, the Royal College of Surgeons, Berlin, and elsewhere. There are altogether sixty-three or sixty-four stuffed skins of the Alca impennis known to exist; many of these contained parts of the skeleton, which have in some cases been removed without injuring the skin. Mr. Newton expressed his intention of placing the specimen he had so perseveringly obtained in the

the hands of Professor Owen, from whom an account of the bird's osteology was anticipated.

Mr. A. R. Wallace has contributed a very interesting paper on the birds inhabiting the islands of Timor, Flores, and Lombock, with descriptions of new species. The chain of islands of which Timor is the last, extends along the east of Java, and forms a natural subdivision of the Malayan Archipelago. The soil of these islands is very dry; active volcanoes are still at work in them, and their origin is probably volcanic. The vegetation consists of spiny and prickly shrubs, the dense forests and luxuriant growths of most equatorial regions being quite unknown. During five months, Mr. Wallace obtained 112 species of birds from Timor—the number of species known altogether being 118; from Flores he obtained 86 species; from Lombock, 63 species; from Sumbawa no collection was made; and the island of Bali belongs to the Indian region, and is therefore not considered in connection with the Malayan groups. The total number of species of birds known to inhabit the Timorean sub-group is 186, and Mr. Wallace makes some interesting comparisons, from the data he has obtained, with the avifauna of the neighbouring islands, which he has so successfully investigated. The presence in the Timorese avifauna of a large number of Australian representative species, and the fact that the species peculiar to Timor approach the Australian types, though at the same time the Javan forms are very abundant and there are few birds of the Javan type which are not identical with species of that island, leads Mr. Wallace to infer that the island was more anciently populated from Australia, while the Javian forms have appeared later, and partially extinguished the Australian types. Timor is now nearly 20 miles by sea from Java, while 300 miles separate it from Australia. A large sandbank however extends from the north coast of that continent to within 20 miles of Timor, and Mr. Wallace believes it probable that this sandbank is owing to the submergence of the land not very long since. It is not likely that an absolute connection by land existed between Timor and Australia, since but one Marsupial, and that of a Moluccan type, is found in the island. Yet we must assume a much closer approximation to the continent, in order to enable us to understand how it happens that though the birds of these islands are, on the whole, almost as much Indian as Australian, yet the apparently endemic species have such a preponderating Australian character.

A list of birds from Damara land, collected by Mr. Anderson, has been communicated by Mr. T. H. Gurney. The same gentleman communicated a list of a small collection of birds from Huaheima, one of the Society Islands. The birds were obtained for Mr. Gurney by Mr. T. H. Wodehouse, H.B.M. consul at Raiatea.

Among the new species of Mammalia described before the Society during the past quarter, is a new squirrel from Natal, which Dr. Gray proposes to call *Sciurus ornatus*; also a new species of seal from the west coast of North America, which Dr. Gray has named *Halocyon Richardii*.

Mr. Flower has been dissecting the Echidna, which lately died at the Gardens in Regent's Park, and has communicated a paper on its cerebral anatomy. He finds that the *corpora quadrigemina* does not, as has been stated by Owen and others, differ materially in this monotrema from the ordinary structure of this part of the brain in other Mammals.

The fishes of the inland rivers and lakes of many countries are so little known, and the circumstances under which they exist are so varied and peculiar, that in nearly every district new and local species are to found. Captain Dow has lately transmitted to England a collection of thirty-one species obtained from Central America, among which Dr. Günther has determined several new species of great interest which he has described to the Society.

An addition to the 1,200 species of Helix is made by Dr. T. E. Cox, who describes a species from Port Denison, N.E. Australia, as *Helix Forbesii*. Mr. Frank Buckland, who has done such good work for our salmon and trout, and also tried to show us a live porpoise in London, has turned his attention to oysters, and has addressed a communication to the Society, in which he advocates the introduction of the American *Ostrea Virginica* into the seas of this country.

Mr. H. T. B. Hancock is performing some experiments on the supposed electrical powers of Octopus, by means of a specimen in the Society's gardens.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

Almost every department of farm management is in active operation during the first months of the year. Land drainage and autumnal tillage have put the fallows in the best condition for deriving fertility from the atmosphere. The direct application of manures to the crop becomes useful and economical as the season of growth commences. Seedtime brings under discussion the various methods at our command for plant improvement. The continuance of stall-feeding on winter food keeps the whole subject of the meat manufacture before the mind of the farmer. And the lambing and calving season recalls for his consideration all those points on which the theory and practice of the improvement of his live-stock depend. It is in the order of these several departments of farm practice that we write the agricultural record of the first three months of 1864.

1. A dry winter had very early in the season put the tillage work of our arable farms unusually forward; and the periods of severe frost which towards the end of winter were experienced have been of the greatest service on all well-drained clays. It is on such lands especially that the steam cultivation of the previous autumn proves superior to the ordinary horse tillage, which on such soils interferes very materially with the drainage of the land.

The extension of this steam cultivation is the great agricultural event of late years, and though comparatively little is heard of it during the winter months, yet it is then especially that its advantages are seen and realized. Fields which have hitherto been kept dry by steep surface lands or ridges and frequent intervening furrows, as well as by the ordinary underground drains, are now left flat and dry, torn up roughly before winter by the engine-drawn cultivator.

The drainage of stiff clay soils has, indeed, till now been rarely thoroughly effected. Trenches have, indeed, been dug some 3 or 4 feet deep and 7 or 8 yards apart, and through pipes placed in them it has been expected that all the rain which falls upon the field will find its way, after gradual penetration, through the soil and subsoil, and filtration by every particle of all this three or four foot deep mass of earth. But after this the upper layer of this mass has hitherto been cultivated in a way which interposes between it and the lower layers what is practically an impervious floor. Three or four ploughings of grain stubbles before the succeeding peas and beans, the passage of long teams of cattle on the floor over which the soil, and under which the subsoil lies is an effectual induration. This floor is fatal to land drainage, and therefore to fertility. It must be broken up, and this can be done effectually only by steam power. Every month of March

for several years we have walked over hundreds of acres of stiff clay land—land needing four horses to the plough—drained and smashed up by steam power before winter, between whose surface and the drains no such floor exists. It has trodden dry, and has then been lying in as wholesome a condition as it is possible for land to exhibit at this season. The only tillage which it has had has been a one-way cultivation, or grubbing by steam power 8 or 9 inches deep during the previous dry weather of October or November. And this land has thus been left a treasure-box whose lock has been effectually picked, of whose stores, made thus accessible, it only needs that use be made by planting well-selected living seed, in order that the utmost fertility may be exhibited at harvest time. Steam cultivation, after drains have been dug and placed, is the way to ensure good drainage. Tillage by steam power, under such circumstances, is the true picklock by which the exhaustless stores of food for plants present in all clay soils, lying now inaccessible, may be laid open to the roots of plants. The breaking up of the floor, which horse cultivation lays immediately below the surface, and the breaking up of soil and subsoil, with the exposure of the whole to air and rain on its way downwards to the drain, will yet exert a marvellous influence on fertility. Hitherto the progress of events has been all to the advantage of the lighter soils. The use of guano and of artificial manures, and the extension of liberal feeding in the sheep-fold, have all been especially to the advantage of our sands and lighter loams. The application of steam power as the auxiliary of land drainage gives now the turn of advantage to the owners and occupiers of our clays; and whereas by marling, sheep-feeding, and artificial manuring the lighter soils have till now been foremost in the march of agricultural improvement, thus contributing more than any other to that increased produce of food which English fields have of late provided, we may now expect that by drainage and effective tillage the stiffer lands will take their turn in front, making the most rapid progress, yielding the largest produce, the most profit, and the highest rent.

All these considerations, and others connected with the best rotations of cropping for clay soils, were discussed at the meeting of the English Agricultural Society on March 16th, when Mr. A. Hughes of Thorness, Isle of Wight, read a paper on the Cultivation and Management of Clay Farms.

2. At a previous meeting of the same Society, Mr. Lawes of Rothamstead had read a paper on the Value of common Salt as a Manure. Its reputation as a fertilizer has, as he believes, hitherto stood too high. It has been said to increase the production of grain, and to improve the quality of straw. It is believed to have great effect especially on crops, such as mangold-wurzel, which are of marine origin. It is said to fix ammonia in the soil, and also to preserve moisture in dry seasons. Mr. Lawes's own experiments have satisfied him that it is of little use.

The two plots of land, A and B, on which these experiments had been tried had both received exactly the same amount of artificial manure, but A, unlike B, received, during 1851, 1852, and 1853, 3 cwt. of common

salt per acre per annum in addition to the other manures. The parallel is exact with that exception. The mean produce of 1848, 1849, and 1850, the years previous to the application of salt, was 32¼ or 32½ bushels per acre in each case; showing that the crops of wheat were extremely alike. There was, in fact, no difference between them. Again, in 1851, 1852, and 1853, the years in which A received 3 cwt. of salt per acre per annum and B did not, the produce of wheat per acre was almost exactly the same. During the next ten years also the produce was again nearly alike. The produce of the sixteen years was in each case 37¼ bushels, showing that in the yield there was no trace whatever of the action of the 9 cwt. of common salt. Some persons think that, although salt may not increase the quantity of produce, yet it improves its quality. What, then, was the weight of the produce per bushel? In the first three years the weight was a little higher in A than in B; in the second three years, when the salt was applied—the difference was again slightly in favour of A, though not so much as it was before; and in the next ten years the weights per bushel were almost exactly alike. The total produce of the first three years was 5,988 lbs. against 5,976 lbs.—a difference of only a few pounds. In the three years when salt was used the produce was, as nearly as possible, the same; and in the ten years after salt was applied, the produce was 7,799 lbs. against 7,811 lbs.—again a difference of only a few pounds. In the total produce of the whole period of sixteen years the difference was only 12 lbs.—7,222 lbs. against 7,234 lbs. Salt is supposed to strengthen straw, and to improve its quality. In the first period, before salt was applied, there was 57 lbs. and a fraction against 56 lbs. of grain to 100 lbs. of straw; therefore A was in that case rather superior to B. In the next period there was 42·6 lbs. against 41·7 lbs., there being again a slight difference in favour of A. Practically there was no difference in the proportions of corn and straw, taking the whole period.

For mangold-wurzels, of which Mr. Lawes grows annually about 15 acres, he has been in the habit, which is prevalent, of applying a few cwts. of salt with the guano which he uses along with a half-dressing of dung. But an experiment last year showed that the crop was unaltered where no salt had been applied, and was diminished where a double allowance of salt had been added. Of course the experience of a single locality will not determine the truth for all England. But Rothampstead, in Hertfordshire, is sufficiently inland to make one expect that there the full effect of salt as a manure would be seen. Though, however, there are undoubted instances where salt has been applied with advantage as a manure, yet in an island such as ours, swept annually by Atlantic storms, it can rarely be the case that the common salt of the soil is the body *in minimo*, whose quantity, according to the accepted theory of manures, rules the crop.

A recent lecture on Artificial Manures, by Professor Anderson, the chemist to the Highland and Agricultural Society, has directed attention to the prices charged for Lawson's so-called phospho-guano, and for ordinary superphosphates. The phospho-guano, as sold, is the result of treating, with a comparatively small quantity of sulphuric

acid, the natural rock deposit which is imported from Monk's Island and other islets in its neighbourhood. Certain reports, by Liebig, Voelcker, and Anderson, of the merits of this substance as a manure, which had been drawn up at the request of Messrs. Lawson to be used as affidavits in connection with a suit brought against them in the Court of Chancery, by Messrs. Thomson, Bonar, and Co., agents for the sale of Peruvian guano, have of late been largely used by them as a trade advertisement, and a good deal of angry feeling has been excited amongst the manufacturers of the cheaper superphosphates by this quotation of *ex parte* statements on high authority against them. The upshot of the discussion, which has been carried on chiefly in the columns of the Scottish agricultural journals, appears to be the admission, on all hands, that it matters not for the agricultural effect of it what may have been the origin, whether mineral or animal, of the soluble superphosphate of lime which exists in any manure; though as regards the remainder of the substance, which has not been acted on by the acid used, but remains in the original condition of neutral phosphate, it is a useful manure in the case of the Monk's Island deposit, and still more so in the case of bones, but it is entirely valueless in the case of the ordinary coprolite, which is the source of most of the cheap superphosphates in the market. The tendency of the discussion will undoubtedly tend ultimately to bring down the present high price charged for the phospho-guano, and assimilate it more nearly to the prices charged for ordinary superphosphate.

The imports of manuring substances during the past year, which have been lately published, show a considerable increase under the head of bones and guano, but a large diminution under the head of nitres. The figures are as follow:—

Imports.	1862.	1863.
	Tons.	Tons.
Bones, whether burnt or not .	67,230	77,492
Guano	141,636	233,574
Saltpetre	22,162	20,225
Cubic nitre	39,716	26,990

3. We come now to such facts of our current agricultural history as are classed under the general subject of plant growth. Perhaps the leading fact under this head is the growing conviction that, thanks to manuring and sheep-feeding on our light soils, and to drainage and better tillage on our clays, the fertility of the arable lands of this country has of late been rapidly advancing, while that of the pasture lands has been stationary. In Gloucestershire a recent inquiry, helped by the records of a Cotswold farm which had been kept for nearly a hundred years, led clearly to this conclusion. Wheat had on that farm doubled its produce per acre since the latter part of last century; barley and oats had not increased correspondingly; but green crops

had largely increased in productiveness, and a much larger quantity of meat is now made per acre than formerly. And this was found to contrast most glaringly with the condition of the dairy districts of the same county which do not now keep more stock, or yield more cheese, and butter, and bacon, than they used to do thirty years ago.

Another fact of some interest under this head, is the extension of the growth of flax during the past year. In Ireland, the following has been the acreage of this crop during some past years:—

	1860.	1861.	1862.	1863.
Acres of Flax .	128,444	147,866	150,312	213,992

The promotion of flax culture in England is creating a good deal of attention. And in many country towns, meetings have been held for the establishment of flax retteries, which, as offering a market for the produce, is necessary as a first step towards the extension of flax cultivation.

The subject of plant improvement, and especially that of our cereals, has been a good deal under discussion in our agricultural journals. Mr. Shirreff, of Haddington, to whom we owe many of our best sorts of wheat and oats, seems to consider that the work of plant improvement is exclusively natural, and that all that we can do is, in effect, to keep a sharp look-out, and whenever we see in any natural sort or variety the qualities we want, take care of the plant, and multiply it as fast as we can.

Mr. Hallett, of Brighton, on the other hand, who advertises at such enormous prices what he calls a "a pedigree" wheat, believes in the power of improving a plant by cultivation. He chooses a promising ear of Wheat—plants all the seeds—takes that plant of the series which is best—chooses its best ear—again plants all *its* seeds—again chooses the best plant, best ear, and best seed—and after a series of harvests thus obtained, during which, as he alleges, the plants and ears have annually improved upon his hands, he takes the ultimate produce as the parents of the grain which he shall offer for sale, and multiplies it by thin seeding and careful cultivation as fast as he can—and so by-and-by the "Z family," or some other of long lineage, is offered to the "faithful," for they alone will venture its price, at perhaps one or two guineas a bushel!

There is probably less difference between these gentlemen than they admit. Both select the best natural origin they can find—both are confident that the progeny will be like the parent—both believe in the fixity of character of the resultant grain: the one, however, thinking that the character is fixed in the origin, and the other, that it is fixed in the successive annual growths of the sort in question.

Neither will deny the immense folly of carelessness in the selection of our seed—and both may well wonder at farmers who when they want a good Cabbage, Mangold, or Turnip, take care to choose a good

plant as the parent of the seed they use, yet the moment they approach the cereals, at once neglect the principle which in the other case they know to be efficient and correct.

A good deal of excitement has prevailed in Ireland and elsewhere, owing to an unusual liability on the part of the Swedish turnip to degenerate into a Rape-like plant, sending all its growth into leaf and stem and refusing to form a bulb. An action against the seedsman for damages, on the plea that the seed was at fault, resulted in a verdict for the defendant, the jury being unable to resist the evidence of the mischief being due to other causes. It appears that the circumstances of the soil may so differ in the same field that rows of plants, from seed sown out of the same seed-box from end to end across it, shall in some places exhibit uniformly good bulbs and elsewhere nothing but leaf and stem. It appears to us that even here a good deal of responsibility rests with the seedman, and seed grown from successive generations of well-selected plants would have that power of resisting the mischievous influence of circumstances and of producing good bulbs in spite of them, according to a long-continued habitude and bent, which Swede seed grown at hap-hazard is found to want.

Seed-time calls to our remembrance the invention of Mr. Smith's (of Woolston) capital combined seed drill and cultivator for draught by steam power. It is being extensively used this spring and will no doubt come largely into operation as a most efficient tool for sowing wheat upon a clean bean stubble, and even occasionally for planting beans upon a clean wheat stubble—certainly for sowing barley after the sheepfold—*at one operation.* It is the latest illustration that we have of the way in which steam power is applicable both to the economizing of farm labour and to the increase of its efficiency.

The character of the wonderful harvest with which England was last year blest, appears from the following classification of the reports regarding it from all parts of the country which have been published by the 'Mark Lane Express.' It will be seen what an immense preponderance of the reports regarding the wheat crop declare it to have been over average.

Reports.	Wheat.	Barley.	Oats.
Under average . .	5	55	65
Average	96	245	268
Over average . . .	523	261	200

4. We have now to refer to points connected with the meat manufacture. The high price of beef, mutton, and wool have all tended to promote in a wonderful degree the extension of the practice of high feeding, which has of late years enormously grown. No great increase of the imports of oilcakes, on which the chief dependence has been hitherto placed, seems from the following figures to be possible.

The following are the imports of Linseed and of Linseed cakes during the past six years:—

	1858.	1859.	1860.	1861.	1862.	1863.
Linseed . . qrs.	1,017,844	1,270,911	1,330,623	1,160,270	1,088,472	1,104,578
Oil cakes . . tons	80,629	95,208	108,826	113,725	101,156	88,566

On the other hand there is a growing conviction of the extent of fraud by adulteration, to which the purchaser of these cakes is liable. The consequence is a probably unprecedented consumption of home-grown grain; and to this the low prices of barley and of wheat have no doubt contributed. Whenever the price of grain or whole meal is one-eighth, or thereabouts, that of meat, it is profitable to use it as food for fattening stock. And of course there is a great additional advantage besides the mere sale at a good price of inferior grain which is derived from this method of their disposal. The enrichment of the manure which is thus affected is an additional profit of great value. To how large an extent this is made use of, let the following example suffice to show. It relates to a farm on the edge of Woking Common, over which we lately walked, where the soil is naturally extremely poor, but made wonderfully productive by a large consumption of purchased food for fattening stock. On about 500 acres of this poor sandy land, close on the edge of what may be called the dreariest waste in the island, a herd of 50 to 70 cows is milked for the London market; a dry flock of Hampshire Downs, varying from 200 to 400 head, is fed; and hogs, ranging in number from 1,500 to 2,000 per annum, are fattened up to 10 or 12 scores a piece. All this is done so long as meat and bacon are at ordinary prices, with a small profit; but the principal advantage no doubt is, that the naturally poor soil of the farm is thus made capable of growing 5 quarters of wheat, 5 or 6 of barley, and 30 to 40 tons of mangold-wurzel per acre. The swine, bought at 5 to 7 score a piece, are kept till 10 or 12, making meat at the rate of rather more than 1 lb. a day, and receiving half a peck of meal daily upon an average, *viz.* one-half barley meal, and the rest wheat, Indian corn, lentils, peas, beans, buck-wheat, or whatever else is cheapest.

Of course, with such a great quantity of stock to feed, purchases of food are very large; 500 up to 1,000 bushels of grain are used weekly; and the annual return of meat—12,000 lbs. of mutton, 150,000 lbs. of bacon, and about 40,000 gallons of milk—equal in all to 200,000 lbs. of meat per annum—amounts to a manufacture of 400 lbs. of meat per acre—which is, we believe, quite unparalleled.

The effect is seen in the high artificial fertility of this naturally poor land. The large quantity of rich manure, deep cultivation, and sheep-treading, are the three agencies employed, and their success, unaided, as in other pure sandy districts, by any possibility of marling or claying the land, has been unequivocal. No contrast is so great as that existing between the luxuriant growth of the fields on the

Hoebridge Farm, near Woking, and the utter worthlessness of the waste close by.

The principal point of recent interest, however, under our present head, during the present quarter, undoubtedly has been the introduction by the Government of the Bill for permitting the use of malt, free of duty, as food for sheep and cattle. Whatever the satisfaction with reference to this measure may be, taking it in some degree to indicate that the Government may hereafter be willing to reconsider the whole subject of the malt tax, there can be little doubt nevertheless that it is in the meantime an utterly worthless concession to the agricultural interest. There are cheaper foods already at our command than ever malt, duty free, will be—and the mixture of the malt with linseed meal, which is one of the safeguards which the Bill provides against those frauds against the revenue which it will facilitate, is no improvement of the material for use in either feeding-stall or sheep-fold.

5. The value of pure-bred stock in the market, which indicates their intrinsic merits in the eye of judges, has lately received a singular illustration in high prices realized at the sales at Towneley and at Sarsden of the short-horn herds which have grown up under the management of Colonel Towneley and the late Mr. Langston, M.P., respectively. The success of the former herd especially. which has been in existence only during the past fifteen years, has been extraordinary. During that time more than 2,000*l.* have been won as prizes, besides 22 cups, 2 "challenge" cups, 26 gold medals, and more than 10 others of silver and bronze.

The only other point to be noticed in our present agricultural chronicle, is the excitement which prevails on the subject of contagious disease amongst our live-stock. Notwithstanding that the mischief is in all probability exaggerated, yet it is bad enough to justify a certain amount of interference and supervision by the Government; and a measure has accordingly been introduced into Parliament forbidding the turning out of stock afflicted with certain specified contagious diseases into public places; enabling the Secretary of State to forbid, if necessary, the removal of cattle or sheep from any infected district; and requiring all carriers to provide cleaned carriages for the conveyance of stock, &c. This, with another measure dealing in a similar spirit with imported live-stock, has been referred to a select Committee of the House of Commons.

It appears that we have 8,000,000 of cattle, 40,000,000 of sheep, and 4,300,000 pigs in the United Kingdom, and that the annual mortality by disease is 5 per cent. of the cattle, 4 per cent. of the sheep, and in Ireland 10 per cent. of the pigs. The total value of live-stock destroyed by disease last year is thus believed to have been 6,120,000*l.* In addition to this their owners had to suffer the loss of condition in the animals which have recovered, and the general public undoubtedly suffer considerably from the consumption of the meat of animals slaughtered when in a diseased condition. These appear to be sufficiently urgent reasons for Government interference.

II. BOTANY AND VEGETABLE PHYSIOLOGY.

The prizes offered by the French Academy in this department of science call attention to subjects of great importance in vegetable physiology, and are three in number; the first Bourdin prize, postponed from 1861 to 1866, March 31st, is for an essay to determine by anatomical research, if there exists in the structure of the stems of vegetables the characters belonging to the large natural families, and thus agreeing with those deduced from the organs of reproduction. Any comparative work on the branches and stems will be admitted to competition. Another prize, postponed from 1860, to September 1, 1865, and to consist of a gold medal, value 3,000 francs, will be given for the determination experimentally of the causes in the inequality of absorption by different vegetables of the solutions of the various kinds of salt which the earth contains, and to recognize by anatomical study of the roots, the connection which may exist between the tissues which constitute them, and the matter which they absorb or give out. A prize, also standing over from 1859, is now offered for 1866 "for the study of vessels of the *latex*, or proper juice, of vegetables, considered in a double aspect from their distribution in the different organs of plants, and particularly their affinities and connections with the lymphatic or spiral vessels, as well as with the fibres of the plant."

The prizes *awarded* in vegetable physiology at the annual meeting of the Academy, were, first, the *grand prize* of 3,000 francs, "to discover what the changes are which take place during germination in the constitution of the tissues of the vegetable embryo and perisperm, and in the matter which these tissues contain." Dr. Arthur Gris, assistant-naturalist to the Museum, obtained the award. The Barbier prize was equally divided between M. Jules Lepère, of Pondicherry, and M. Veillard, a naval surgeon; the first having presented a paper on the study of the different medicaments used in India, and comparisons of them with those which our European plants furnish; also, researches into the Hydrocotyle Asiatica, and its use in medicine. The second writer presented a work relating to the medicinal and alimentary plants indigenous to New Caledonia, throwing light upon the therapeutic use of vegetables as yet but little known, but studied in two most important colonies, by officers attached to the naval medical service of France.

A prize awarded for a chemical rather than for a botanical subject may be alluded to here. M. Bouffé received 1,500 francs reward for his natural green (*vert nature*), a mixture of picric acid and Guignet's chrome green, intended to replace the arsenical greens, so much sought after on account of their beauty and brilliancy, but so dangerous to the makers of artificial flowers.

While upon the subject of prizes we may mention that the Royal Horticultural Society of London, in order to foster the study of scientific botany, has offered the following prizes for botanical collections:—1. One silver and two bronze medals for the three best

collections of dried wild plants of each separate county, classified according to the natural system. 2. Three gold medals for the best three of all the collections out of all the several county collections. These collections must be arranged according to a natural method, and be accompanied by a list arranged according to the same method, with the species numbered. The collector is to follow some work on British botany, such as Babington, Hooker and Arnott, or Bentham, stating the work adopted. The collections must be delivered on or before 31st December, 1864, to the Secretary of the Royal Horticultural Society. Further, the Society will present a gold medal to every exhibitor of a new species of plant found growing in the United Kingdom. We need hardly point out that these regulations offer an excellent opportunity to the members of the various Field Naturalists' Clubs which are scattered throughout the kingdom, and we anticipate that the stimulus thus publicly offered by the Royal Horticultural Society will be productive of the most beneficial results.

At the January sitting of the Academy of Sciences of Vienna, M. Ettingshausen exhibited a work about to be published under the title of 'Photographic Album of the Flora of Austria, being at the same time a Manual of Botany.' This is the first time that the photographic reproduction of vegetables has been attempted as a new and important means of botanical instruction. Hitherto it has been found impossible to obtain good photographs of plants, the images being black simple sketches without shade, on account of the green colour of the objects. Last year, the author, in giving an account of the recent progress of what he terms *autophysiotypie*, communicated to the Academy that at the Imperial Printing Office they had been able not only to obtain good photographs of plants, but also to engrave them so as to reproduce them by printing. The work above alluded to is the realization of this beautiful method. It embraces a complete selection of characteristic species of all the families of the Austrian flora, and interspersed with the text are the photographic portraits of hundreds of plants, just in the manner of woodcuts. M. Ettingshausen has also presented a memoir on the nervation of ferns, illustrated by the process of *autophysiotypie*.

Mr. J. Hill of Cambridge, Mass., gives an account of some observations upon the compass plant (Silphium laciniatum) which he found growing wild near Chicago, last autumn. The field had once been ploughed, and sowed with Timothy grass, and there was a grove a few rods to the east. Notwithstanding these unfavourable circumstances, he took a rough measurement of thirty plants, without selection, as follows:—Holding a card over each plant with its edge parallel to the central line of his own shadow, he marked upon the card a short line parallel to each leaf of the plant. Measuring afterwards the angle which each mark made with the edge of the card, and subtracting from each angle the azimuth of the sun for the estimated central time of observation, he obtained the following results. Only one plant, bearing four old leaves, gave an average angle with the meridian of more than 34° Their mean was 18° W. The remaining twenty-nine plants

bore ninety-one leaves, which made with the meridian the following angles, *viz.*—Seven made angles greater than 35°; fifteen, angles between 35° and 20°; sixteen, angles between 20° and 8°; twenty-eight, angles between 8° and 1°; and twenty-five, angles less than 1°. Of the sixty-nine angles less than 20°, the mean is N. 33′ E., *i.e.* about half a degree east of the meridian. The error of azimuth, from want of means to determine the time accurately, may have been as much as three times this quantity. One half the leaves bore within about half a point of N., and two-thirds within one point. The magnetic declination was about 6° E., and the observations were made when the sun was about on the magnetic meridian.

Henna (Lawsonia inermis), a plant which has been so long used in Egypt as a cosmetic and dye stuff, has been introduced into commerce by MM. Gillet and Tabourin, of Lyons. According to the 'Coloriste Industriel,' the researches of these chemists show that the active colouring principle is nothing more than a peculiar kind of tannic acid, which they propose to call *hennatannic* acid. The dried leaves of henna contain half their weight of this substance. The plant is, it appears, particularly useful for imparting to silk the different shades of black, the colours so obtained being very beautiful and permanent.

At the Academy of Sciences of Vienna Dr. de Vry exhibited some beautifully-crystallized resin of the upas tree (Antiaris toxicaria), also the upas poison itself in a crystallizable state. He regarded the poison as a Glycosite, that did not act upon the stomach as a violent poison, perhaps not as a poison at all, and possessed poisonous properties only when brought into immediate contact with the blood. He had convinced himself by repeated personal experiment that the stories of the poisonous atmosphere of the upas tree are fabulous.

Further investigations into the milk vessels of Leontodon (the common dandelion) by Dr. August Vogt, of Vienna, show that the intercellular substance occurring in the root consists chiefly of *pectose*, the same substance which occurs in unripe fruits, and in turnips and carrots; so that it is not a secretion, but a product of conversion of the cellulose of the cell-membranes, of a chemical nature. The milk vessels occurring in the dandelion are amongst the most ramified which occur anywhere in plants, springing from main stems, then ramifying and forming ultimately large reticulated systems around the woody nucleus. On examining into their origin, it appears that their main stems are produced by the amalgamation of the so-called conducting cells which accompany the bundles of milk vessels, and probably constitute the organ for conducting back the juices elaborated in the leaves. This fusion is induced by the conversion into pectose of the membranes of the cells, consisting at first more or less entirely of cellulose.

Some interesting observations have been made by Henrici on the functions of roots in supplying water to the plant, and on the development under certain conditions of special roots destined for this purpose, to explain the frequent occurrence of plants sending roots into

wells, cisterns, drain-pipes, &c., where they exist in continual contact with a body of water. In drain-pipes the roots of plants usually considered to be free from aquatic tendencies, such as rape (brassica), sometimes accumulate to a surprising extent. Henrici surmised that the roots which most cultivated plants send down deep into the soil, even when the soil is by no means porous or inviting, are designed especially to bring up water from the subsoil for the use of the plant. He devised an experiment for the purpose of establishing the truth of these views, by planting a young raspberry in a funnel filled with garden soil, the neck of the funnel dipping into water from which it was separated by a paper filter. Roots penetrated the soil and the filter, and became *water-roots*, which being ultimately cut away, and the plant put into soil and placed in a conservatory it grew vigorously. Henrici considers that he has proved that plants extend a portion of their roots into the subsoil, chiefly for the purpose of gathering supplies of water.

III. CHEMISTRY.

Chemical science has made steady progress during the past quarter. Not only do the proceedings of the various learned societies chronicled in these pages, the Royal, Chemical, and Royal Institution, show that our chief workers have not been idle, but the records of progress which we are about to give, are also evidence of important advancements which find their way to the public through other channels than the leading societies.

Deserving perhaps the foremost place, stand the researches of Professor Graham, Master of the Mint, on the Molecular Mobility of Gases. The researches of this philosopher on liquid diffusion must be fresh in the memory of every chemist, resulting as they did in the introduction of a new and most valuable means of analysis into the laboratory. The present investigations* prove that the same laws which he has already shown to apply to liquids in their passage through porous diaphragms, likewise influence gaseous bodies. In researches of this character the difficulty has been to find a porous body whose structure was sufficiently compact to prevent the passage of the gas *en masse*, but yet to permit its molecules to have free movement. Thin plates of compressed black-lead have at last been found to possess the desired property, and by employing this material as the porous septum in the diffusiometer several remarkable results have been obtained. Space will not permit us to give even a brief abstract of the whole of this important paper, we will, therefore, content ourselves with drawing attention to one or two of the most striking results. The separation of the gases of the atmosphere by transmission through a porous material has a peculiar interest, although from the nearness of the densities of oxygen and

* 'Philosophical Transactions,' part ii. 1863; and 'Philosophical Magazine,' xxvi. 409.

nitrogen no great separation can be effected by this method; the diffusive velocity of two gases being inversely as the square roots of their densities, nitrogen exceeds oxygen in activity by about 6·7 per cent. By experiment, about three-fourths of the theoretical separation was actually obtained, and other experiments were then instituted, with a view of ascertaining what would be the effect of other porous bodies, such as stucco, or earthenware, on atmospheric gases, and the result shows that all porous masses, however loose their texture, will have some effect in separating mixed gases, moving through them under pressure. The air entering a room by percolation through a wall of brick, or a coat of plaster, will thus become richer in nitrogen, in a certain small measure, than the external atmosphere. Where such a small difference of specific gravities exists the separation of gases is a severe trial to the powers of the atmolyser, but with greater disparities of density the separation may become very considerable. When an explosive mixture of one volume of oxygen and two volumes of hydrogen are transmitted, the result is very striking, the hydrogen diminishes from 66·66 to 9·3 per cent., and the gas ceases to be explosive, a lighted taper burning in it as in pure oxygen. In other experiments on the diffusion of carbonic acid into air, the remarkable result was discovered that in perfectly still air its molecules spontaneously alter their position, and move to a distance of half a metre in any direction in the course of five or six minutes, whilst the molecules of hydrogen disperse themselves to the distance of a third of a metre in a single minute. The Professor considers that such a molecular movement may become an agency of considerable power in distributing heat throughout the atmosphere.

The new element Cæsium has been the subject of further investigation by Bunsen;* he separates it from Rubidium by converting the two metals into tartrates, and adding a sufficient excess of tartaric acid to convert the rubidium into bi-tartrate whilst the cæsium salt remains neutral. The mixture is then exposed in a funnel to an atmosphere saturated with moisture, when the neutral cæsium salt deliquesces and runs through, while the acid rubidium salt remains behind. Bunsen has deduced, from cæsium compounds so purified, the equivalent 132·99; whilst Johnson and Allen, working with very much larger quantities of material than Bunsen was able to obtain, deduced the number 133·03. These fully authorize the use of the round number 133 as expressing the combining proportion of this element.

The very rare metal Vanadium is likely to be somewhat more available for scientific research, if not for practical applications, now that Riley† has found it to occur in the Wiltshire oolitic iron ore and in the pig-iron smelted from it. He finds that this pig-iron will readily furnish any quantity of vanadium with tolerable facility; it appears to contain more vanadium than that made from the Taberg

* Poggendorf's 'Annalen,' cxix. 1.

† 'Journal of the Chemical Society,' New Series, ii. 21.

ore in Sweden, and it is supposed that this is the first time that this metal has been found in English pig-iron.

A note on the Quantitative Determination of Sulphur by Dr. D. S. Price,* deserves notice, as it draws attention to a source of error which is very liable to be overlooked by analysts. He finds that the ordinary method of estimating sulphur, by fusion with nitre over gas, is liable to error in consequence of the coal gas giving sulphur to the contents of the crucible. Experiments show that nitre, which before fusion was free from sulphur, contained an appreciable quantity after exposure to a gas flame for three quarters of an hour.

Perhaps one of the most important problems in analytical chemistry is to obtain the reagents of that exceptional purity which is absolutely necessary in many researches. In toxicological inquiries it is, of course, of vital importance that the sulphuric acid should be free from that very common impurity arsenic, and chemists will on this account be glad to know of a method by which this difficult problemn can be solved. The method of distillation as ordinarily practised is of no value, but it may be made available with the modifications introduced by MM. Bussy and Buigne.† These chemists have shown that when the arsenic exists in the state of arsenious acid it distils over, but when it is present as arsenic acid the whole remains behind in the retort. Upon boiling the suspected acid with a little nitric acid, or, as Maxwell Lyte proposes,‡ by adding a little bichromate of potash and then distilling, the product will be perfectly free from arsenic.

A new pigment, which appears likely to afford a ready means of preserving iron and other metals, has recently been introduced in Paris by M. Oudry, of the Auteuil electro-metallurgic works. Pure copper is first precipitated by the galvanic process, and it is then reduced to an impalpable powder. This powder is then mixed with a preparation of spirit and used as ordinary paint. The articles coated in this way have all the appearance of electro-bronze, while the cost is less than one-sixth; it is likely to last from eight to ten years, and beautiful effects are produced by means of a dressing of acidified solutions and pure copper powder.

A patent has recently been entered by M. Clavel for modifying the beautiful blue dyes obtained from coal tar, so as to render them soluble in water. He dissolves the dye in fuming sulphuric acid and then dilutes the solution considerably, passing steam in at the same time. The colouring matter is then precipitated in flocculi by the addition of common salt; upon washing the salt out, the dye remains perfectly soluble in water. Whilst speaking of these aniline dyes we may mention with pleasure that the parent to whom they all owe their origin, Dr. Hofmann, has been honoured by the Jecker Prize of 5,000 francs, given by the Paris Academy of Sciences, for his researches on artificial organic alkalies.

* 'Chemical News,' viii. 285.
† 'Journal de Pharmacie et de Chimie,' xliv. 177.
‡ 'Chemical News,' ix. 98.

In these days of falsification it may be of some interest to give a simple test for artificially-coloured wines, which we owe to Blume. He saturates a piece of bread crumb with the wine to be tested and places it in a plate full of water. If the wine is artificially coloured, the water very soon becomes reddish violet, but if the colouring matter is natural, the water, after a quarter or half an hour, is but very little coloured, and a slight opalescence only is perceptible.

From its ready liberation of sulphurous acid, hyposulphite of soda is likely to become a valuable bleaching agent; M. Artus has applied it very successfully to the bleaching of sponges. He first washes them in a weak solution of caustic soda, and then, after thorough rinsing with water, transfers them to a weak mixture of hyposulphite of soda and dilute hydrochloric acid. In a short time the sponges become nearly white, without having their valuable qualities injured in the least; they are then to be taken out and well washed.

The Calabar bean has been well investigated physiologically in this country, but the alkaloid, to which it owes its wonderful property of contracting the pupil of the eye, has only very recently been isolated by MM. Jobst and Hesse;* they have given it the name of Phytostigmine, and as yet have only found it in the cotyledon. It is a brownish-yellow amorphous mass, easily soluble in ether, alcohol, and benzol, and slightly soluble in cold water. Its aqueous solution has a decidedly alkaline reaction. It produces very strong contraction of the pupil, and one curious fact observed, is that the poison produces contraction of the pupil when applied to recently-dead animals. Now that Calabar bean is so extensively used by ophthalmic surgeons, the isolation of its active principle cannot fail to be of value.

Poison bottles and poison corks, poison caps and poison stoppers, have all successively been tried, with the object of preventing careless or sleepy nurses from giving medicines out of the wrong bottles and thereby poisoning their patients; but they are all open to the objection that when the liquid for which they have been originally used is exhausted, the very nice-looking bottle is generally replenished with eau de cologne, tincture of senna, or such-like innocent compounds, and the object of having a peculiarly-contrived bottle is thereby defeated. Perhaps the most unobjectionable of all these attempts to substitute a mechanical contrivance for ordinary caution and common sense, has been recently brought forward by Mr. Thonger before the Pharmaceutical Society. It consists of a patent label having a border of sand-paper round it, thus appealing strongly to the sense of touch, which it is presumed will warn the holder that danger is near. These labels are applicable to dispensing bottles and to the smallest phials, and possess an advantage over any other contrivance, as they can be stuck on any vessel, and as readily removed when the poisonous contents are done with and the bottle is required for something else.

The Society of Medical Sciences of Brussels some time ago offered a prize for the discovery of a substitute for the Cinchona alkaloids.

* 'Annalen der Chem. und Pharm.' cxxix. 115.

The silver medal has recently been awarded to Dr. Leriche for his memoir on the Employment of Tannin as a substitute for Cinchona. He arrives at the conclusion that pure tannic acid is an excellent antiperiodic, and possesses real efficacy in the treatment of all intermittent fevers of a simple quotidian type. Now that we are threatened by some alarmists with a Quinine famine, the discovery of anything which can be used to supplement, or replace, this invaluable drug is of the very highest importance.

IV. GEOLOGY AND PALÆONTOLOGY.

The past quarter has not been unmarked by some important attempts at progress, and amongst these Professor Frankland's effort to evolve a Meteorological theory for the causation of the Glacial era will, whether accepted by geologists or not, rank as one of the best towards a solution of this recent and remarkable geological period. But as in mathematical demonstrations everything depends on the basis taken, so in that excellent chemist's hypothesis the correctness of his conclusions is dependent upon the establishment of the assumptions upon which his hypothesis is built—namely, on the actual existence of an internal molten core within our earth, and the gradual cooling down of our planet from an original incandescent state. The argument Dr. Frankland holds is, that the formation of glaciers is a true process of distillation, requiring heat as much as cold for its due performance. The produce of a still would be diminished, not increased, by an absolute reduction of temperature, and it is a wider differentiation of temperature that is required to stimulate its operation into fuller activity. The great natural Glacial apparatus is divisible into three parts—the evaporator, the condenser, and the receiver. The ocean supplies the vapour, the mountains are the ice-bearers or receivers, but the dry air of the upper region of the atmosphere, which permits the free radiation into space of the heat from aqueous vapour, is the true condenser. The sole cause of the phenomena of the Glacial period, then, Professor Frankland believes, was a higher temperature of the ocean than obtains at present, and the greater differentiation brought about by the difference of the rates of cooling of the water of the sea and of the rock-masses of the terrestrial crust. According to his notions, all the waters of the ocean primarily existed in the atmosphere as vapour, and with the gradual cooling of the earth they were first allowed to be deposited upon it in a thermal liquid state, and subsequently these ocean-waters have been gradually reduced to their present temperature—the glacial phenomena occurring during the later stages of this cooling operation. Those effects were brought about chiefly by two causes—the high specific heat of water compared with granite and other rocks, and the comparative facility with which radiant heat escapes from such rocks through *moist* air. The amounts of heat associated with equal weights of water and granite are as 5 to 1, or, if equal volumes be taken, water

requires to lose twice as much heat as granite in order to cool through the same number of degrees. But in regard to the escape of radiant-heat through moist air, there is a high degree of difference between them. It seems that radiant heat will not pass from a given substance through the vapour of that substance so rapidly as it will through dry air or a vaporous medium of any other substance; and just as the vapour of sodium cuts off the light rays of sodium in the spectrum, so the vapour of water seemingly, to a great extent at least, arrests the radiant-heat rays emanating from water; and thus, while there is free radiation from the snow-capped mountains into the dry regions of the upper air, the radiation of heat from the sea is blocked by the "blanket" of aqueous vapour which rests over its surface. Whilst then the ocean in the Glacial era retained a temperature considerably higher than at present, Dr. Frankland considers the mountains or ice-bearers had undergone considerably greater refrigeration; and thus whilst the evaporation of the ocean, receiving heat through its earth-floor from the internal molten core of our planet, was in much greater volume than now, the mountains were not very different from their present state, and were efficient ice-bearers for the vapours condensed in the upper atmosphere, and falling upon them as snow, which, accumulating in vast quantities, would not only reduce the level of the perpetual snow-line, but refrigerate also climatal conditions. Not content with this earth alone, Professor Frankland attempted, though not very successfully, to apply his Glacial hypotheses to the moon, seeking there for traces of glacial action. Assuming the solid mass of the moon to have contracted in cooling at the same rate as granite, its refrigeration, though only 180° Fahr., would, he calculates, create a cellular space within its crust of upwards of 14 millions of cubic miles, or more than sufficient to engulf the whole of the lunar oceans, if any proportionate to the seas of our own earth ever existed there. His final conclusions are, that a liquid aqueous ocean can only exist on a planet so long as the latter retains a high internal temperature, and that the moon becomes in this respect a prophetic picture of the ultimate fate of our earth, "when, deprived of external seas and all but an annual rotation on its axis, it shall revolve round the sun an arid and a lifeless wilderness." The hypothesis is clever, and contains germs of philosophy and truth, but we doubt if geologists generally will accept it, at least in its totality.

Although the internal-heat and gradually-cooling doctrines are pretty generally accepted as theories, and not as still unproven hypotheses, these topics, with the Glacial period and the causes of earthquakes, still seem productive of a kind of geological nightmare, which disturbs and terrifies not a few reflective intellects. The Rev. Professor Haughton has introduced some of them into an able paper before the Geological Society of Dublin—"An attempt to calculate the Duration of Time involved in Geological Epochs." Commenting on the vagueness of idea involved in the "long periods of time" habitually spoken of, he undertook, as a point of interest, to estimate, upon the basis of a gradual cooling down of our globe, for how long a time it has been possible for animals to have existed on it. For this estimate the basis selected was Helmholtz's deduction from the experiments on the

cooling of basalt by Professor Bischoff of Bonn—that if the whole globe were constituted of that rock, it would take 350 millions of years to cool from 2,000° to 200° Centigrade. If the earth, then, has cooled down from a gaseous condition to its present consistence, it is evident animals could not have existed on it before it acquired solidity. Even after this it is difficult to believe in the general existence of life at temperatures above that at which albumen, the chief ingredient of flesh, coagulates. The Professor therefore takes a range from this point, 122° Fahr. to 77° Fahr. the temperature which has been suggested for our island in the London-Clay period, and sufficiently near to Professor Heer's estimate from the evidence of fossil plants of 72° for Switzerland in the Miocene age to acquire credibility. Upon these data, Professor Haughton concludes that the earth, if of basalt, would have required 1,280 millions of years to become cooled through the required space since animal-life was possible on our planet.

Not less important, although to some extent going over old ground, is the admirable analysis M. Paul Gervais has made of the evidence of the osseous caverns of Languedoc in respect to the antiquity of man. Much, indeed most, of this evidence has been long before the world, but the treatment it has now received is more scrutinizing and resultful than any hitherto accorded to it. The first documents on this subject are those of M. Tournal, who in 1827 noticed the association of the bones of man with those of extinct species of animals in the caverns of Bize. Two years after, M. Christol published his notice of other fossil human bones from the cavern of Pondres, examined by himself and M. Dumas. Cuvier did not ignore the principal facts thus brought forward, but he never regarded them as sufficient to cause him to change his preconceived opinion, and he objected to them that they were merely cavern-remains, and not found in regular beds, such as those which contain the bones of elephants, rhinoceroses, the great bears, lions and hyænas; the eminent naturalist's notion being that in caverns the relics of various ages were liable to intermixture from natural causes, as well as accidents, and that the objects in contiguous positions might therefore be of very different dates. M. Gervais now takes the fullest evidence he can get of the caves of Bize and Pondres, and to the consideration of them adds new facts obtained from those of Roque and Pontil. The cavern of Bize is chiefly known through the long memoir of M. Marcel de Serres, who records, besides many species still found in the district, an extinct antelope, *A. Christolii*, and four kinds of deer equally annihilated and distinct from any described species—the *Cervus Destremii*, *C. Reboulii*, *C. Leufroyi*, and *C. Tournalii*. The Aurochs is also cited, although it is more likely the remains were those of *Bos primigenius*. The humerus attributed to the Arctic bear is probably that of the ordinary bear of the European mountains, as M. Gervais has obtained fragments of the latter from Tour-de-Farges and Alais. The *Antelope Christolii* did not differ greatly from the chamois. Two portions of the canons of a chamois in M. Gervais' possession consist of only the digital ends and a very short portion of the diaphysis, from which he concludes that these bones were violently broken, and by the act of man—the long bones cracked by the primitive men

for the sake of their marrow being distinguishable from those crushed by animals, even when they occur together in the same deposit. M. Gervais has also a digital extremity of the posterior canon and other similar fragments of the long bones of *Bos primigenius* separated from their middle portions by violent fracture, evidently accomplished by the hand of man. By referring to M. de Serres' plates in conjunction with specimens recently obtained, this able palæontologist concludes that the majority of the extinct deer referred to belong to the Reindeer, and remarks that they exhibit this distinctive feature, that the long bones, instead of being entire, as they are in such caverns as those of Brengues which were not inhabited by man, have at Bize been broken; so that if the men of the Cave period had not domesticated these animals, they at least made use of their carcases. It may not be superfluous to add that this cavern contains the débris of primitive pottery, flint-knives, and implements set in deer's horn and in bone. The cavern of Pondres also contains diluvian animals —*Rhinoceros tichorhinus*, ox, cave-bear, *Felis spelæa*, and hyæna, and has often been quoted in support of the high antiquity of man in Europe, remains of his skeleton, his flint knives, and coarse pottery or charcoal having been found in it. These, according to M. Gervais, are mixed pell-mell with the remains of the extinct animals, whence he questions whether there has not been some amount of intermingling. All that he can positively assure himself of is, that the bones of the large animals have not been broken like those met with in caverns which have served as habitations for the primitive inhabitants of our globe, and he consequently doubts the conclusions of MM. Christol and Dumas as to the contemporaneity, in this instance, of the relics of the fossil mammals and those of man with whom they are associated. In respect to Lunel-Viel, M. Gervais thinks it can scarcely be cited in favour of the contemporaneity of man with the extinct diluvian species, as, notwithstanding the restricted extent of the caves in which the human bones have been found, no traces of its inhabitation by man, nor any relics of works, have been brought to light. He considers, therefore, that this cavern belongs to the class of those which M. Steenstrup regards as entirely filled before the agency of man; and he is the more inclined to this opinion, as the animal-bones are not broken by human methods, but are merely crunched by the teeth of carnivora, especially hyænas. He asks, hence, whether, as a general rule, we may not conclude, when the marrow-bones of the food-beasts are intact, that the commminglings of the human with the animal-remains have not been due to the subsequent intervention of floods, burials, or various other upstirrings of the deposits in which such commminglings occur—an opinion confirmed by the following facts from the cavern of Pontil:—Some years since, M. Gervais found there numerous bones of extinct species, as at Lunel-Viel and Pondres, also human bones and some industrial relics; the former belonging to a primitive epoch, and the last, more recent, had also been shown to him as coming from the same cavern. At that time he abstained from speaking of them, not having sufficiently reliable particulars. Now, however, he is better qualified to

do so. M. Chausse, Conducteur of Ponts et Chaussées, has made excavations at Pontil, and forwarded to M. Gervais the greater part of the objects of human origin found there, with particulars of their bedding and mode of preservation compared with those of the extinct animals embedded with the rhinoceros. The great extinct beasts, including the *Bos primigenius*, are thus shown to be in a lower bed than those deposits which have yielded the bones of horse, human débris, and the remains of ancient fires, a flint-knife and various instruments made of deer's horn and bone exactly like those of the first period of the Swiss Lake dwellings and met with in the Kjokken-möddens of Denmark. Moreover, with these was obtained an upper maxillary of a young *Bos primigenius*, corresponding to one of like age from Lunel-Viel, with which it was compared. In the same cavern in the uppermost sediments, were the tusks of the wild boar, and axes of polished stone, such as are considered to be characteristic of the Second Stone Age; and further manufactured objects indicative of the Age of Bronze, have also been obtained. The cavern of Roque was discovered by Boutin, and the bones from thence were some years since shown to M. Gervais, who then requested search to be made for worked flints, of which, indeed, a considerable quantity has subsequently been found associated with human remains. M. Gervais has also secured a metatarsal of the cave-bear. The broken bones in this cavern belong to deer, common ox, and to an animal indicated by M. Boutin in his notice as a goat, of which we may form some conception by supposing it to have exceeded the dimensions of living goats as much as the *Bos primigenius* exceeded living oxen. M. Gervais provisionally names it the *Capra primigenia*. M. Gervais' conclusions from the above facts are, that the first appearance of man in the districts of the caverns of Bize, Saint-Pons, Pondres, and La Roque, although they must be assigned to a period prior to the records of history, cannot yet be admitted to have been, in this region at least, contemporaneous with the existence of those extinct animals to which Cuvier made allusion when thirty years ago he repelled the statements of Tournal, Christol, and Marcel de Serres as to the simultaneous entombment of men and the extinct mammalia in these caverns. The importance of the distinctions marking the particular faunas which have disappeared, and the chronology of these extinctions become, under such reasonings, topics exceedingly evident, and their value in attempts at determining the contemporaneousness of the human remains and relics with the other objects with which they are found must not hereafter be overlooked.

In the Colonies the study of Geology has of late years gained many active students, and we are glad to find in the 'Transactions of the Nova Scotian Institute,' only very recently established, Geological papers of considerable merit. Mr. Belt's remarks on some recent movements of the earth's surface have a tone of interest for us we could scarcely have expected, and refer much to the mother-country and its continental offshoot—the vast island of the Pacific Ocean. The subjects that formed the basis of his paper are chiefly the raised beaches on the shores of the British Channel, described by Mr. Godwin-

Austen, in the 'Quarterly Journal of the Geological Society,' and the rise of land in Australia. It is easy to understand how corals could build up in the course of time great masses of limestone, the difficulty is to account for the breaking up of ancient sea-bottoms, and their upheaval above the level of the ocean-surface. Now, of Australia, it has been known for several years that the whole coast is slowly but surely rising; and in the southern part, the railway between Adelaide and the port is said to have risen 4 inches in 12 months. This elevation is participated in by all the neighbouring islands; at Green Island in Bass's Strait, and in Tasmania, there are old sea-beaches 100 feet above high-water. And one of the most remarkable and suggestive facts in this recent elevation is, that the movement, without tremblings, quakings, or shocks, is so rapid that bones of animals, and pottery thrown out of the first emigrant ships, mixed with shingle and sea-shells, are raised above the reach of the tide. This uprising has progressed to the extent of 300 feet since the present mollusca inhabited the coast. In New Zealand, too, the land is being jerked up as it is on the western coast of America. From these topics Mr. Belt goes to the superficial deposits of sand, gravel, and clay, that are spread over the greater part of Great Britain; the evidence afforded by which seems to indicate in some places upheavals, in others depressions. Convinced that some general law must govern these movements, Mr. Belt has collected and collated, from various sources, sections of deposits from different parts of England and Scotland; and to render the movements more intelligible, has depicted them by means of curved lines, in a similar manner to those used by meteorologists to indicate the fluctuations of the barometer. Movements of the earth's surface are in this way depicted from examples taken from the most southern part of England, and from the other extremity of the island, 350 miles apart, and for the purpose of showing how general these movements have been another diagram is given of the changes of level in Nova Scotia in recent geological times, and another of a portion of North America, when the land stood, at one time at least, 500 feet higher than it does now. These few widely-separated examples are sufficient to prove what was well known before, the general instability of the earth's crust, but the diagrammatic method of showing these elevations is very suggestive of the utility of symbolizing earth-movements in this way for comparison.

The western coast of the Peloponnesus is a region little known to geologists, and every detail from thence is consequently valuable. We are glad, therefore, to see that an interesting sketch by Dr. Weiss, the Professor of the University of Lemberg, in Gallicia, of a journey made by him in that district, has been laid before the Imperial Institute of Vienna. He notices many very productive localities for Tertiary fossils, which, by a proper exploration, he thinks would lead to very interesting results—although the fossils are abundant, the Doctor, in consequence of the wretched social condition of the country, made but a scanty collection, and is unable to give even an approximately full account of its physical aspect. From the town of Zante the view extends over the Bay of Gastuni to Katakolo, the highest point of which is marked

by the walls of Pondiko-Kastron. Towards Arcadia the coast flattens, and opens an uninterrupted panorama of the hill-plateau of the Morea, terminating on the north in the peaks of the Cyllenic mountains, and on the south by the rocky portions of the Taygetos. The Cape consists of a coarse-grained marine limestone, of Upper Pliocene age, in many places exhibiting the old borings of molluscs, and overlaid by deposits of sand and marl, which cover the undulating ground for miles along the sea-shore, and up to the base of the mountains in the interior. The stone-marl around Pyrgos abounds in *Ostrea lamellosa*, and in the limestone and sandstone are species of *Cardita*, with *Cardium edule*, *Turritella communis*, *Venus multilamella*, and *Scalaria pseudo-scalaris*. Pyrgos itself stands on a colossal oyster-bank, portions of which are exposed to the eye in many parts of the town. It is overlaid by a thick stratum of marl, in which but very few fossil remains are to be found. Dr. Weiss's sketch is principally a description of the routes taken, and will be a useful guide to future explorers of this unworked region.

Dr. Carte has recorded the discovery of bones of the Polar bear in Lough Gur, county Limerick. In the paper before the Dublin Geological Society, in which he has described them, he comments on the extreme abruptness with which, in the newer formations, mammalian forms have appeared in abundance, contrasting in this respect with the gradual appearance of the lower forms of life in the older strata.

The second part of the excellent monograph of Rissoidea, by MM. Gustav Schwartz and Mohrenstern, of Vienna, contains the genus Rissoa, illustrated by four fine lithographic plates. The author gives in a diagrammatic form the relationships of the recent and fossil species, referring the 30 recent species to 11 items in the Pleistocene age, these again to 6 in the Pliocene, these to 4 in the Miocene, 2 in the Oligocene, and finally to one derivative, the *Rissoa nana* in the Eocene.

Mr. S. V. Wood, jun., has published an admirable article on the Red Crag and its relation to the Fluvio-marine Crag, and the Drift of the Eastern Counties. From the result of his survey he comes to the conclusion, that in the Red Crag, once regarded as of Miocene age, we have the initiatory stage in England of that series of events which, known under the term "Drift," began by the encroachment upon the land of England of a bay of the Northern Ocean, and which encroachment afterwards extended over the area of the Eastern Counties, and ultimately involved the submergence of that still more extensive area now covered with the ice-borne detritus and clay of the northern Drift.

There is often more information to be got from, as there is certainly less trouble in reading, a pamphlet of a single sheet. In England we have had Professor Ramsay strenuously contesting for the ice-scooped origin of the Swiss lakes, and the eloquent Ruskin as enthusiastically defending the powers of weather and water upon, and the effects of molecular motion within, the rocks. The learned professor of Berne, M. Studer, now appears before the world in a *brochure* of 16 pages, which he opens with the admission, that "in the origin of the Swiss Lakes we have a problem difficult to resolve," and of

which it is hard to assign precisely the date in the series of geological events. On the one hand we have Buch, Hoffman, and Ball, fully persuaded that the same causes which elevated the Swiss mountains produced the depressions which separate them. They think that the elevation was accompanied by *crevasses* more or less profound, which have formed the valleys, and that in the interior there exist other cavities, the roofs of which will be subsequently broken in—the present lakes being the remains of such cavities or founderings which have not yet been filled up by the silt brought down by the rivers. On the other hand, the disciples of Buffon, Playfair, and the Werner school, attribute the valleys and water-basins to erosion, or the destructive action of fluids in motion. The latter class, as we have already noticed, are split into two parties, and disagree as to the nature of the erosive medium—the one following their ancient masters, look to the currents of the sea, rivers, and torrents; the others, amongst whom are some of our own, and French and continental geologists, advocate the newer theory of their having been scooped out by the grinding action of massive glaciers. Each of these theories may be justified by particular facts; and M. Desor, at least, adopts them both, and applies either one or the other, as circumstances demand, distinguishing the lakes as orographic, and lakes of erosion. The former may be further divided into three classes—the lakes in synclinal valleys, such as the lake of Bourget; those in isoclinal, such as Brienz and Wallenstadt, and those in the transverse valleys or *cluses*, of which the lakes of Thoune and of Uri are examples. The lakes of the Alps, according to M. Desor, are chiefly orographic; whilst those of Neuchâtel, Bienne, Morat, Zurich, Constance, and others in Lower Switzerland, are lakes of erosion. The question of the epoch of their formation is, however, very much complicated when the strata around them are examined. All over Lower Switzerland and the Jura are spread the well-known "Alpine blocks," which by their mode of transport would necessarily have passed above the lakes in arriving at their actual sites from their original beds; and we cannot conceive why, if a current brought them, it should not have filled their basins and made a great mound of débris at the débouchures of the Alpine valleys. This difficulty involving the impossibility of the suspension of such blocks in mid-air, or the unlikelihood of their sustention on the surface of water 1,000 feet above the valley below, has been one of the main causes of the readiness with which the hypothesis of the former greater extension of the glaciers has been received, for across the surfaces of the ice-filled depressions the Alpine blocks would have naturally travelled from the Alps to the Jura. This general body of ice, covering all the valleys and deep hollows, is certainly a cause of uncertainty as to the epoch of the formation of the lakes, for they may evidently be anterior to the glacial epoch, their basins during that era being filled with water or ice; or they may be posterior, although M. Studer is not disposed to admit a posterior origin, which appears too recent to reconcile with the evident connection of the basins and valleys with the orography of the country.

Another difficulty occurs. For a long time there has been known

to exist below the boulder-drift a *terrain erratique*, a deposit of sand and clay horizontally stratified, and possessing all the characters of a river deposit—the *terrain du transport* of Elie de Beaumont, or the *alluvion ancienne* of Necker, the *diluvium* of recent authors—in the gravels of which the constituent rocks of the pebbles are found to be derived from the Alps or the sub-Alpine hills, whilst the boulder-blocks themselves also present different characters, according to the nature of the different valleys through which they have been carried, and corresponding to the rocks *in situ* in such valleys and their tributaries. It is evident, as M. Studer remarks, that the presence of this ancient alluvium throws us again into all those difficulties from which we thought ourselves freed by the hypothesis of the former greater extent of the glaciers. The difficulty, he thinks, may perhaps be diminished by reducing as much as possible the *mass* of those gravels, the transport of which across the lakes, before the great extension of the glaciers took place, seems incontestable; and that, as these horizontal beds of ancient alluvium repose upon the denuded or sliced-off edges of the inclined beds of molasse, the date of their formation is necessarily placed between the catastrophe which elevated the Tertiary beds and the epoch of the great extension of the glaciers. After a careful analytical survey of the physical and geological aspects of the lake-country, M. Studer comes to the conclusion of the insufficiency of erosion in accounting for the origin of the valleys and lakes of the Alps; and he considers there is no alternative but to recognize with M. Escher an intimate connection between a great number of the Alpine valleys and the inclined positions of the beds of the mountains which separate them. These, then, are true orographic valleys, such as M. Desor has noticed in the Jura, and to the two kinds he has described, the synclinal and isoclinal, there ought to be added for the Alps another—the anticlinal valleys. The *cluses*, he further considers, are evidently fractures enlarged by erosion; and he adds a fourth class of valleys—those of subsidence. If lava-currents, which often traverse loose sand, do not burrow into the soil in their progress, is his argument, how can glaciers which have less power than even such currents of water as our senses will not detect the motion of, and which even at this slow rate move over an under-plane of water and ground-adherent ice, effect such enormous erosion as is involved in these lake-basins? He looks, therefore, to subsidences as their chief cause. In this case the ancient alluvium at the bottom of the basins involves the supposition of the lapse of a considerable period of time between the disturbance and the filling up of the depths of the *crevasse;* and as a proof of the occurrence of such an interval, he refers to the great difference between the faunas and floras of the last or newest beds of the molasse, and the first or oldest of those of the alluvium, urging how great a length of time it would require to produce such differences of climatal conditions as to enable a fauna such as that of the Confederate States to supplant the present fauna of Europe—a difference which is not greater, however, than that between the animals of the Molasse age and the elephants, oxen, and deer of the Diluvium.

V. MINING, MINERALOGY, AND METALLURGY.

The most noteworthy fact in connection with British mining which has presented itself during the quarter, has been the production of gold from the quartz lodes of the Cambrian Hills. Many years have passed away since we were told that gold was to be found in Merionethshire. Some of the precious metal was exhibited in 1851, but this had been obtained at a cost which far exceeded its value. In 1861 the Vigra and Clogau mine gave 2,784 standard ounces of gold to the adventurers, but in 1862 they obtained 5,299 ounces. For some time the prospects were dull; large quantities of quartz were worked containing no visible gold, and an infinitesimally small proportion was separated by amalgamation. However, the prospects brightened towards the close of the year 1863; and during the past quarter the following quantities have been duly reported:—

	Oz.	Dwts.		Cwt.	Qrs.	lbs.	
1.	103	11	from	7	1	23	of quartz.
2.	185	16	„	8	1	14	„
3.	296	16	„	10	3	0	„
	586	3		26	2	9	

This is perhaps the most extraordinary yield on record of gold from a quartz vein. We find, however, by the report of the Vigra and Clogau Mining Company, that since the date of their last report, 1,059 ounces of gold have been received, this being obtained from quartz giving 24 ounces of gold to the ton on the average.

In the neighbourhood of Bala Lake some discoveries were made last year, from which much was expected. This has not, however, been realized. But in January some quartz was operated on from Castell-carn-Dochan, giving from 5¾ ounces to 7½ ounces to the ton. At Penrhos and Tynyrhenrhos, stones have been taken from quartz lodes containing visible gold. The extraordinary products of the Vigra and Clogau mine naturally awaken the hopes of the adventurers in the other gold-mines around Dolgelly. It should, however, be borne in mind by all, that nothing can be more capricious than the occurrence of gold in the quartz lodes. We know not when the gold may disappear—we have no rule to guide us as to its discovery. Therefore, caution should be the rule of all speculators, who are tempted by the auriferous treasures of the Welsh mountains.

British mining presents but little that is worthy of our record. The fact that upwards of 10 tons of nickel and cobalt speiss has been obtained from the sandstone of Alderly Edge, in Cheshire, is of interest.

In our last number we drew especial attention to the coal-cutting machines of the Ardsley Coal Company, and of Ridley and Jones. Mr. Firth, of the former company, informs us that the Ardsley machine has been reduced to two feet in length, "therefore," he says, "in the progress of invention we have gone far beyond the one in question." The

Ardsley machine is being used in several collieries, and the reports are in the highest degree satisfactory.

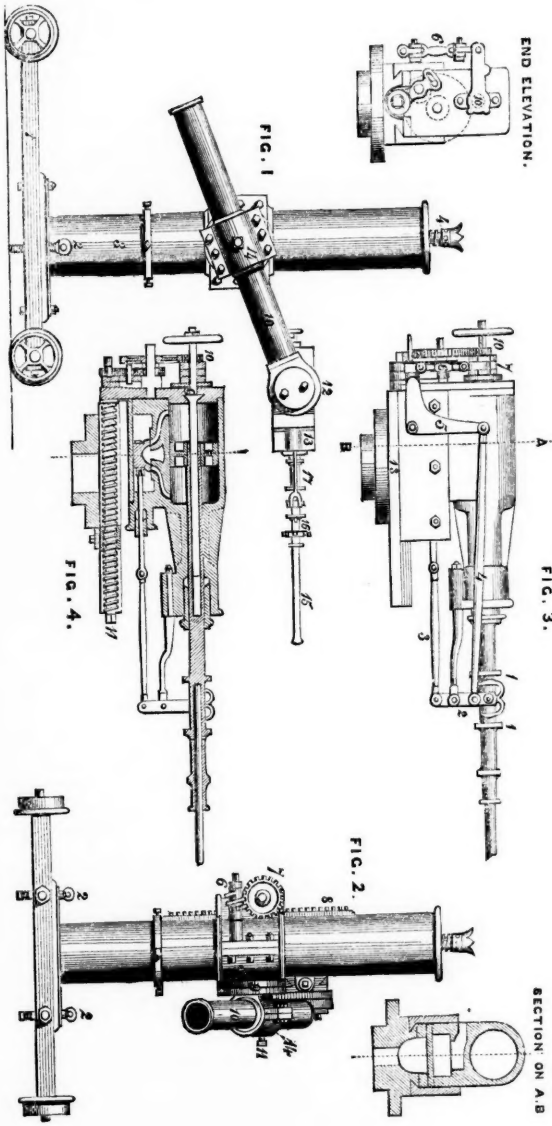
In connection with this really important subject, a very admirable paper was read at the Institution of Civil Engineers, on February 16, by Mr. Thomas Sopwith, jun., on "The Actual State of the Works on the Mount Cenis Tunnel, and Description of the Machinery Employed."

So much has been said of late respecting this extraordinary undertaking, and of the machinery employed in boring this tunnel, that we need not occupy our pages with any description of either the one or the other. The following brief quotation shows the present rate of progress:—"The tunnel, on 30th June, 1863, had been driven (including the advanced gallery), at Modane, 1092·25 metres, and at Bardonneche, 1450·00 metres. The advancement in June last, at Modane, was at the rate of 4·719 feet per day. At this rate of progress at both ends, the tunnel would be finished in nine years two and a-half months from that time."

The machine employed by M. Sommeiller is very accurately described, and admirably-executed drawings are given in a work by M. Armengaud (aîné).* In the same work will be found a description of a rotating perforator, "perforateur rotatif," of Schwartzkopf and Phillipson. This machine is exceedingly portable, and especially applicable to the conditions which prevail in our metalliferous mines.

Attention has been directed, since the experiments which have been made at Mont Cenis, to the use of boring machinery in the metalliferous mines of this country. A machine, invented by Mr. Crease, but resembling strongly the machine just noticed, has been used in the Vigra and Clogau gold mine, near Dolgelly. The result of the trials made in driving a level, went to show that several improvements were required; consequently it was placed in the hands of Mr. Green, of Aberystwyth, and that gentleman has shown much mechanical ingenuity in adapting new principles to the original idea. The improved, or Green's boring machine, is shown in the accompanying plate. This machine consists of (Figs. 1, 2) an upright pillar of cast-iron, 3, fixed upon a low tram waggon, 1, running upon rails in the level, and having within it, in the upper part, an upright screw, 4, and cross-head; and in the lower part another screw, 2, by means of which the machine can be firmly fixed between the floor and the roof. This pillar is encircled by an iron collar, 5, which can revolve round the pillar, but which can, by means of a rack and pinion, 7, 8, worked by the worm, 6, be raised or lowered upon it. Attached to this collar is an arm with adjustments, 9, 10, 11, 14, which carries the boring machine proper (Fig. 4). At the end of the arm is a cylinder resting upon a screw bed (Fig. 3), 15, in which works an ordinary slide valve. The piston is shown in section in Fig. 4; to it is attached a hollow piston-rod, in which the borer is placed. By the side of the cylinder are

* 'Publication Industrielle des Machines, Outils et Appareils les plus perfectionnés et les plus récents, employés dans les différentes branches de l'industrie française et étrangère.' Par Armengaud (aîné). Paris: MM. A. Morel et C^ie^. See also 'Les Mondes, Revue Hebdomadaire des Sciences,' 21 Jan., 1864.


END ELEVATION.
FIG. 1
FIG. 4.
FIG. 3.
FIG. 2.
SECTION ON A B

attached the connecting-rods, marked 3, 4; one working the slide valve, the other acting by levers 5 and 6, giving motion to a ratchet-wheel, which, acting on a system of tooth-wheels 10 (see end elevation), cause the piston and borer to make a quarter of a revolution. These levers are worked at each stroke by means of projections on the piston-rod 1·1. The revolutions can also be effected by hand, through the wheel and connection, 9; and this marks the main difference between the machines of Crease and Green—the former having only the means for making the revolution by hand.

At the same time that the borer makes its quarter revolution, the screw 11 is caused by tooth-wheels to make an equal turn, giving a forward motion to the cylinder, and bringing the borer more into the hole.

This machine can be worked by either steam or compressed air, the latter being the most convenient, and at all times to be preferred, especially in driving the badly-ventilated end of long levels.

These notes and the accompanying drawing will show that the borer can be placed in any position with regard to height or direction in a horizontal plane. There is also a joint Fig. 1-12, by which it can be adjusted in any direction in a vertical plane.

We are informed that Mr. Crease's boring machine has been recently introduced in two mines near Tavistock, and we know that experiments are being tried in some of the lead mines of the North of England, and in the copper mines near Camborne, Cornwall. Another boring machine for "driving tunnels, mines, adits, shafts, quarries, &c.," has been constructed and patented by Mr. George Low, of Newark. In its more important features it does not differ materially from that already described. We are informed that Mr. Low's machine has been applied with success by the Connoree Mining Company. The machine can be made with one, or any number of borers, which, on an average, will bore holes at the rate of two inches per minute, as proved by actual trial. We hear of several other machines, some to be worked by air or steam, or by water pressure, and others to be moved by manual labour. The attention which is now being directed to the important question of relieving men from the severe tasks of boring rocks in the confined ends of levels, appears likely to result in the production of some simple and efficacious mechanical arrangements.

The advantages of employing machines of this class are great: economy in working should at once recommend them to the mine proprietor, and on the score of humanity, as removing from living muscle its severest toil, and giving it to unwearing metal, the philanthropist should urge their introduction. Another advantage would be gained by using compressed air machines; the impure air of the levels would be dispelled by the escape of that which we had used to bore our rocks.

In a journal such as ours it is important that we should preserve a record, easily available, of the progress of our special industries, The report of the Registrar-General on the census of 1861 enables

us to compile a list of persons who were then connected with our mining operations. From this it appears that 1,012,997 persons are engaged in the great order of workers in minerals. Of these 248,284 are connected with coal pits; 32,041 are tin or copper miners, 18,552 are lead miners, 20,626 iron miners, 7,502 are indefinitely described as miners, 2,502 are described as secretaries and servants of mining companies.

Women are still employed at coal works, chiefly at the pit's mouth, their number being 3,763. We learn also that 142,170 males are employed on stone and slate quarries and in clay works; and 2,120 in the salt works of the kingdom. The workers in the metals we exclude from our notice, since these are too extensive, and they are not, in all cases, sufficiently defined.

With this large number of people employed, and producing, as they do annually, mineral wealth to the value of 30,000,000*l.* sterling, it is astonishing that no effective system of education has taken root in this country, which can be regarded as possessing the requisites of mining schools. There must be some strange prejudices lurking in the popular mind, or this state of things would cease to be.

The English language is poor in technological literature of any kind, and poorest of all in its literature relating to mines, minerals, and metallurgy. This arises from the circumstance that we are a working, and not a writing, people. There are but two weekly journals of any note devoted to mining, these are 'The Mining Journal,' and 'The Colliery Guardian,' and there is one small monthly magazine, 'The Mining and Smelting Magazine.' These are the only representatives of our very important industries. If anyone inquires for a work on British Mining, we are compelled to confess that there is no such book in the English language.

In the German and the French languages there are many periodicals devoted to mines and metallurgy, and to these we must be indebted for much of our information. The best papers indeed, on several metalliferous mining processes, as carried forward in this country, are those of M. Moisenet, which were published in the 'Annales des Mines.'* Many valuable papers on our mines and mining machinery, and many of the highest character on the manufacture of iron, are to be found in the 'Revue Universelle des Mines, &c.'† It is not a pleasant thing to acknowledge our poverty, but it is satisfactory to know that our several industries are of sufficient importance to demand the attention of such journalists as those who conduct the two works which we have named. In the 'Revue Universelle' occurs an admirable paper by M. S. Jordan, on the mines and metallurgical industries of France. From this we learn that the consumption of coal in France amounts to 15,300,000 tons, while the production is only 9,400,000 tons, yet this is an

* 'Annales des Mines; ou Recueil de Mémoires sur l'Exploitation des Mines, et sur les Sciences et les Arts qui s'y rapportent.' Paris: Dunod.

† 'Revue Universelle des Mines, de la Métallurgie, des Travaux publics, des Sciences et des Arts appliqués à l'Industrie.' Sous la Direction de M. Ch. De Cuyper. Paris et Liége: Noblet et Baudry.

increase of 4,500,000 tons in the last ten years. The production of pig-iron in 1862 was 1,053,000 tons, which was double the quantity made in France six years previously. Our space will not allow of our quoting from the papers by A. Burat, E. Bède, and others on the special subjects which belong to this division of our Chronicle. We cannot, however, refrain from directing our mining engineers to a "Note sur quelques perfectionnements introduits dans l'exploitation des Mines," par Jules Havrez, which appears in the August part of the 'Revue Universelle.' It appears to us to offer many valuable suggestions, by which they might profit. The "Etudes sur l'Acier," by M. de Cizancout, in the 'Annales des Mines,' is a communication deserving the attention of our metallurgists. Professor Rivot has an instructive memoir on the 'Veins of Argentiferous Galena' of Vialas (Lozère). To our miners this paper should be a model, upon which they might build a record of their own experiences.

In the report recently published of the progress of the geological survey of Canada, under the direction of Sir William Logan, there is much matter of especial mineralogical interest. The chapters devoted to the consideration of "mineral species" may be consulted with advantage. They make us acquainted with several modified conditions of known minerals, and with a few which appear to be new varieties. Amongst the metallic minerals which have been discovered in such quantities as to give them a commercial value we find nickel and cobalt, chromic iron, iron ores in considerable variety, copper, lead, silver, and gold. The magnetic oxide of iron has been found in great abundance, this valuable mineral giving 72·4 parts of iron, and 27·6 parts of oxygen. A satisfactory description of the lead and copper mines of Canada is given by the Geological Surveyors. It would, however, have been interesting and important if the present rate of production had been ascertained. As Canada is destined to become a great mineral-producing country, the progress of its economic geology would have formed a very appropriate *addendum* to the report on its scientific geology.*

Gold occurs in this colony, both in veins and in the drift. Some idea of the value of the auriferous deposits may be formed from the following quotation:—"It has been shown that the washing of the ground over an area of one acre, and with an average depth of two feet, equal to 87,120 cubic feet, gave in round numbers about 5,000 pennyweights of gold, or $1\frac{8\,8}{1\,0\,0}$ grains to the cubic foot, which is equal to $1\frac{3}{4}$ grain of gold to the bushel." Several other minerals useful in the arts and manufactures are succinctly noticed, and the occurrence of plumbago especially described, this mineral occurring in a state of considerable purity.

A very interesting description of the production of the bitumens, especially of the petroleum of Gaspé, is, at the present time, important.

* 'Geological Survey of Canada. Report of Progress from its Commencement to 1863, illustrated by 498 Woodcuts in the Text, and accompanied by an Atlas of Maps and Sections.' Officers of the Survey—Sir William Logan, Alexander Murray, T. Sterry Hunt, and E. Billings. Montreal: Dawson Brothers. London: Baillière.

The wells of this district are chiefly in an area of about four square miles in the first three ranges of Enniskillen. When these wells have been opened, the petroleum has risen to the surface of the earth, constituting what are called "flowing wells." One of these, which was sunk to a depth of about 200 feet, is said to have yielded, when first opened, not less than 2,000 barrels in twenty-four hours. The Enniskillen petroleum wells have produced as follows from the time of their opening:—

	Barrels.
Previous to July 31, 1861 . . .	5,529
Half-year ending January 31, 1862 .	6,246
Do. do. July 31, 1862 . .	25,264
Do. do. January 31, 1863 .	57,550
For the month of February 1863 . .	8,874
Number of barrels of 40 gallons each .	103,463

Giving a total yield of 4,138,520 gallons.

Other districts are named from which petroleum can be obtained, although as yet the quantities in which it is likely to be produced are uncertain, as no sufficient exploration has been made.

This Report, extending to 980 pages, is a valuable contribution to our scientific literature.

M. Damour has communicated a paper to the *Académie des Sciences* on the "Density of Zircons." He has given a long list of these precious stones which he has examined. We select the results obtained in a few instances only, as showing the variation of density to which they are subject:—

The Zircon of Ceylon—green colour .	4·043
Do. of India—blue tint . .	4·596
Do. of Brevig—brown . . .	4·613
Do. of the Ural—yellow brown .	4·669

The indices of refraction are shown to vary in these minerals with their density.*

A meteorolite found near Louvain, in Belgium, has been examined by M. Pisani, and found to contain—

Nickelliferous iron, with tin and traces of phosphorus	8·67
Pyrites	6·06
Chromate of iron	0·71
Silicates	84·28
	99·72

A full account of this stone was communicated to the *Académie Royale de Belgique*, and will be found in their Transactions. The *Académie des Sciences* of Vienna has also been occupied with the consideration of meteoric masses. M. Haidinger described the occurrence of meteoric iron found at Tucson, in the territory of Avezana, United States; and read a communication on a meteorolite observed at Vienna on the 10th

* 'L'Institut: Journal Universel des Sciences,' January 20, 1864.

of August.* M. Gustav Rose has communicated to the Academy of Berlin notices of six aërolites.†

M. Henry Sainte-Claire Deville brought under the notice of the Academy of Sciences a new mineral found by M. Breithaupt in Greenland, and to which he has given the name of Carphosiderite.‡ This mineral is very rare, and it was supposed by E. Harkort to be a subphosphate of the hydrate of iron; but Deville says:—"After the study which I have made of carphosiderite, I am able to say that it is a subsulphate of the peroxyde of hydrate of iron mixed with sand and a little gypsum."

An interesting paper has reached us on "The Gems of Australia," read before the Royal Society of Victoria, by Dr. Bleasdale. From this we learn that the following gems have been found in our important colony:§—Diamonds, sapphires, ruby, topazes, beryls, garnets, opals, amethysts, and jaspers. The ruby, of which one only has been found, alone requires notice. It was found in Queensland, "and cut in Melbourne by Mr. Spink, and turned out to be a star ruby, of good size and great beauty. This stone is, I think, new. It belongs to the Asterias, but instead of having a floating star of six rays of white light, it has a fixed star of six black rays in a deep blue ground."

Dr. Bleasdale offers some very sensible suggestions on the importance of instructing the gold miners in a knowledge of precious stones, and of forming a good collection of them in the local museums.

We conclude our chronicle of mineralogy by drawing attention to a machine recently patented (of which a working model is exhibited in Liverpool), for the reduction of "charcoal and other friable substances to fine or impalpable powder, particularly applicable to the manufacture of a substitute for lampblack." The apparatus is of the simplest kind, consisting in the main of cylindrical vessels, into which the material to be reduced is placed along with a great number of small balls or spheres of iron, glass, stone, &c., to which rotary motion is then imparted at any speed required.

The inventor claims for his machine the power to reduce a great variety of substances to an impalpable powder, as fine as lampblack; and amongst those named in the specification of patent are, colouring earths, barytes, marble, bloodstone, litharge, emery, gums, pepper, &c.

The invention is a Swedish one, and is in charge of Mr. Lee, 16, Leeds Street, Liverpool, who exhibits the working model.

Although the well-determined processes of metallurgy leave us nothing in the way of progress to record, our metal manufactures appear to advance with great rapidity. Our attention has been directed to a new process for drawing steel tubes, which is now exciting considerable interest. The following description, which is most exact, we borrow from 'The Times' newspaper:—

* See 'L'Institut,' February 17, 1864.

† See 'Les Mondes,' February 11, 1864.

‡ Breithaupt in Schweiger's Journal, Bd. L. S. 314.

§ See also Dicker's 'Mining Record and Guide to the Gold Mines of Victoria,' December 24, 1863.

"Steel tubes are one of the difficult problems of our hardware manufacture. They are very costly to produce, and very unequal in their tenacity when they are turned out, the weld, when the tube is joined down the middle, always proving its weakest and almost its unsafe part. Steel wires, however, of any thickness or of any fineness, are drawn every day, and by a very simple development of the same process a machine has been invented by which steel tubes of any thickness or internal diameter can be produced with the same certainty. In a few words, it may be said that the new method consists of substituting the slow, equal, but irresistible force of hydraulic pressure for the ordinarily rapid but somewhat uncertain steam power of the wire-drawer's bench. The whole machinery consists of a hydraulic press, with double cylinders placed *vis-à-vis* with a single piston, which as it leaves one cylinder enters the other, and which, at its junction between the two, carries a powerful collar or flange of iron. To this flange the steel tube to be drawn out is secured in a die or gauge of the requisite shape, while down inside the tube itself passes a steel rod, which fits into the circle of the die or gauge, just allowing the requisite aperture round its circumference to regulate the size of the tube drawn over it. Thus, when once the machine is set in motion by its pump, the tube, held by its outer collar, is slowly drawn over the inner rod, which, according to its thickness, reduces the tube by pressure against the outer die to any fineness, and therefore to any length that may be required. Several tubes were thus drawn yesterday in the presence of a number of engineers and scientific gentlemen at Mr. Almond's works, Willow Walk, Bermondsey; and the results, both as to the mechanical trueness of the tube and its perfect homogeneousness throughout, were in the very highest degree satisfactory. Nor is it circular tubes only that can be drawn by this process. By altering the shape of the outer die and inner rod to square, triangular, or octagon, the same form of tube is produced with equal certainty and equal strength, though in order to avoid distressing the metal it is only reduced $\frac{1}{16}$ of an inch at each passage through the machine. The movement is so slow that the tube comes out almost cold, yet burnished like the finest steel inside and out. The great pressure, however, to which it is subjected has a tendency to harden the metal, so that when many reductions of size are necessary, it has to undergo annealing to keep it at the required toughness. After being drawn to whatever shape or length is required, the finished tube can be tempered up to any degree of hardness, or annealed down to its strongest stage of toughness as may be wanted. The whole process is neither an invention nor a discovery, but simply a most valuable development of our present means of manufacture."

We understand that there are scarcely any limits to the sizes of which the tubes can be drawn. Within all the ordinary requirements of our engineers, drawn-steel tubes can now be supplied.

VI. OPTICS.

Since the beautiful researches of Faraday on gold-leaf, the relation of metals to light has scarcely met with the attention which so important a subject deserves. M. G. Quincke has recently published* an elaborate investigation on the optical properties of metals. We have not space even for an analysis of this long paper, but we will mention a few of the most important results at which he has arrived. Plates of gold, silver, and platinum were employed, so thin as to be transparent, and these were examined in the same way as other transparent bodies. When light falls upon a thick plate of metal it penetrates to a depth which is about as great as the length of an undulation, the so-called metallic lustre being produced by the conjoint action of the exteriorly and interiorly reflected or dispersed light. The velocity of light through metals is one of the subjects studied by the author, and he has obtained, in the course of this investigation, the remarkable result that light travels faster through gold and silver than through a vacuum. But Faraday has shown that silver and gold films occur in different modifications, and M. Quincke finds that gold and silver metallic plates, through which light passes with a greater velocity than through air, may become spontaneously altered by simple standing, so as to transmit light with less velocity than it is transmitted by air. In the case of platinum it was always found that the light passed through with less velocity than through air. The ordinary polished silver and gold possess the same character as that modification of these metals which transmits light with the greater velocity. Their refracting indices are therefore less than unity.

The second part of Kirchhoff's researches on the solar spectrum and the spectra of the chemical elements, translated by H. G. Roscoe, F.R.S.,† has just been published. It completes the Professor's survey of the solar spectrum, and contains two plates, one extending from A to D, and the other beginning at the point where the second plate in the former publication ended, and extending as far as G. The actual observations have been taken by M. K. Hofmann, a pupil of Professor Kirchhoff's, his own eyesight having been too much injured by his previous observations to allow him to continue the investigation. The new metals examined consist of potassium, rubidium, lithium, cerium, lanthanum, didymium, platinum, palladium, and an alloy of iridium and ruthenium. These additional observations have not yielded any new information respecting the constituents of the solar atmosphere; they have, however, confirmed the results of the previous examination. Potassium, which was formerly considered to give lines identical with some in the solar spectrum, now appears to be absent from that luminary; a few coincidences have also been observed in the spectra of strontium and cadmium, but their number is too small to warrant the conclusion that these metals are present in the sun's atmosphere.

* 'Poggendorff's Annalen,' vol. cxix. part 3.

† Macmillan and Co.

The plates are lithographed in ink of different tints, and form as perfect a representation of the spectrum lines as it seems possible to obtain.

M. Van der Willigen has communicated * the results of some determinations of the indices of refraction of twelve rays of the solar spectrum for distilled water. Every precaution has been taken to secure accuracy, and the readings have been taken to one second. We give the results for the eight Fraunhofer rays:—

A	1·32899
B	1·33048
C	1·33122
D	1·33307
E	1.33527
F	1·33720
G	1·34065
H	1·34350

A very interesting experiment in spectrum analysis has been described by M. Louis Grandeau.† During a stormy night he arranged a spectroscope at his window, so that the lightning could illuminate one-half of the slit, whilst one of Geissler's nitrogen vacuum tubes was sending its light in through the other half of the slit. A small quantity of vapour of water which remained in the nitrogen tube at the time it was prepared was sufficient to produce the characteristic ray of hydrogen superposed on the nitrogen rays. M. Grandeau was able for an hour, at intervals of about five minutes, to observe the spectrum of the lightning, the general appearance of which at first sight recalled that of the electric spark; but on closer observation he soon noticed in the spectrum of almost every flash the coincidence of a certain number of the rays of its spectrum with those of the spectra of nitrogen and hydrogen. This is easily understood when we remember that ammonia and nitric acid are produced under the influence of the electric discharge.

The solar radiation has long been supposed to exercise a marked action upon all bodies exposed to its influence. The difference observed between plants which have grown exposed to its full power, and others which have received but a limited share of its action, is generally very great. M. Bourgeois has lately made some observations on meadow grass, part of which was fully exposed to sunshine, whilst the other part was grown in a shady spot. After it had been converted into hay, that portion which had had the full benefit of the sun was greedily eaten by some horses, whilst they refused to touch that which had been grown in the shade. Upon subjecting the two kinds to distillation by steam the sunned portion was found to be much richer in odoriferous principle than the other. These experiments show that other evils besides actual paucity of crop spring from a dull cloudy summer and autumn, whilst sunshine, besides increasing

* 'Comptes Rendus de l'Académie des Pays Bas.'

† 'Practical Instructions in Spectrum Analysis.' Paris: Mallet Bachelier.

the actual yield per acre, causes it to grow of a much better quality. There is no doubt that what is here shown to be the case with grass holds good equally with cereal and other crops.

A lifetime might be spent in investigating the mysteries hidden in a bee-hive, and still half of the secrets would be undiscovered. The formation of the cell has long been a celebrated problem for the mathematician, whilst the changes which the honey undergoes offers at least an equal interest to the chemist. Everyone knows what honey is like when fresh from the comb. It is a clear yellow syrup, without a trace of solid sugar in it. Upon standing, however, it gradually assumes a crystalline appearance—it *candies*, as the saying is—and ultimately becomes a solid mass of sugar.

It has not been suspected that this change was due to a photographic action—that the same agent which alters the molecular arrangement of the iodide of silver on the excited collodion plate, and determines the formations of camphor and iodine crystals in a bottle, also causes the syrupy honey to assume a crystalline form. This, however, is the case. M. Scheibler* has enclosed honey in stoppered flasks, some of which he has kept in perfect darkness, whilst others have been exposed to the light. The invariable result has been that the sunned portion rapidly crystallizes, whilst that kept in the dark has remained perfectly liquid. We now see why bees are so careful to work in perfect darkness, and why they are so careful to obscure the glass windows which are sometimes placed in their hives. The existence of their young depends on the liquidity of the saccharine food presented to them, and if light were allowed access to this the syrup would gradually acquire a more or less solid consistency; it would seal up the cells, and in all probability prove fatal to the inmates of the hive.

The Magnesium Light is gradually attracting more and more attention, as there appears to be a probability of the metal being obtained at a reasonable price. At a recent meeting of the Manchester Literary and Philosophical Society, Professor Roscoe exhibited the light emitted by burning a portion of a fine specimen of pure magnesium wire, one inch in diameter. In a memoir on the subject by Professors Bunsen and Roscoe, they show that a burning magnesium wire 0·279 inch thick evolves as much light as 74 stearine candles, 5 to the pound. In one minute about ·12 grammes of magnesium would be burnt, and in 10 hours about 72 grammes or a little over 2 ounces. In order to produce the same light with the candles for 10 hours, there would have to be burnt about 20 lb. of stearine, so that could magnesium wire be produced at a few shillings per ounce our houses might at once be illuminated by this easily managed and intensely powerful light.

A good photometric process, easy of application, and tolerably accurate in its results, is, and perhaps will long remain, a desideratum. One of the best which has come under our notice has just been devised by M. Z. Roussin; he dissolves equal parts of dry perchloride of iron

* 'Journ. de Pharm. et de Chimie,' 1863.

and nitroprusside of sodium in ten times their weight of water, and in this manner forms a liquid which is highly sensitive to light, deposing Prussian blue as a precipitate under the influence of luminous action, whilst it remains quite clear in darkness. He therefore prepares this liquid in obscurity, and takes its specific gravity. After exposure to the light he filters off the precipitated Prussian blue, and again takes the specific gravity of the clear liquid. It will of course have diminished in density by the amount of solid matter separated, and the difference between its former and latter specific gravity will represent the chemical action, the numbers obtained varying directly with the intensity of the light.

The Electric Light appears to have permanently taken its place amongst theatrical properties. In Paris, where more attention is paid to scenic effects than in this country, the celebrated optician Duboscq has devised some marvellous imitations both of lightning and of the rainbow. The former is obtained by a concave mirror, in the focus of which are the two carbon poles of a powerful battery nearly in contact, and so adjusted that when the mirror is rapidly moved in the hand the poles are caused to touch for a brief interval, and flash a dazzling beam of light across the stage. The zigzag effect of lightning, and its peculiar blue colour, are very perfectly imitated by this means. But more wonderful than this is the rainbow. In the representation of the opera of *Moïse* it is requisite in the first act to introduce a rainbow, and this has hitherto been effected either by painting or by projecting the image on the scene from a magic lantern by means of a coloured slide. In the latter case the stage had to be darkened in order to allow the rainbow to be seen, and this of course destroyed the illusion. M. Duboscq, by a happy modification of his spectrum apparatus, and by employing a curved instead of a straight slit, and a small-angled prism, has succeeded in projecting the very brilliant electric spectrum on the scene, with the proper curvature and the identical colours of the real rainbow, and this of such a vividness that it is plainly visible in the full light of the stage. In these days of sensation-spectacles we feel confident that a real rainbow on the stage would attract quite as crowded houses as a "tremendous header," and it is somewhat surprising that no manager thought of introducing so novel an effect last Christmas.

If our Continental neighbours have not yet supplied us with all their electric effects, they have not hesitated to make full use of the Dirksian ghost, which has so long reigned unrivalled at the Polytechnic under the energetic management of the director, Mr. Pepper. In the last act of the '*Secret de Miss Aurore*,' as performed at the Théâtre Impérial du Châtelet, the ghost of Conyers is made to confront his assassin, Softy, with incorporeal bank-notes in his hand, and poetic justice is supposed to be avenged by the horror which seizes the murderer when he finds himself unable to grasp them. But the head-quarters of the ghostly illusion are at the *Séances* of M. Robin, perhaps the most scientific of modern followers of Cagliostro. In availing himself of the now well-known machinery necessary to produce the ghost illusion, he combines the experience of a wizard with the appliances of a man of science, and

succeeds in producing some of the most startling illusions of the day. He does not attempt to instruct his audience, but candidly tells them that he is going to employ the whole of his complicated electrical, voltaic, and optical machinery to deceive their eyes and to astonish them. No one can say that he does not succeed in both these attempts. His scene of "the violin of Paganini," and the one in which he represents himself as struggling in the embrace of death, are perhaps the most real illusions which have ever been brought before the public.

VII. HEAT.

The determination of the mechanical equivalent of heat has been one of the great triumphs of modern times. The numerical relations have been obtained by many experimenters, but the methods have been liable to very great errors of manipulation. One of the most accurate series of determinations has just been completed by MM. Tresca and Laboulaye.* The principle upon which they work is to allow a given volume of air to expand, and then to measure the amount of heat which it has absorbed during the operation. Into a reservoir holding 3·28 cubic metres, air is forced until it has a pressure of three atmospheres. A mercury gauge is connected with the receiver, and a float on the upper portion of the mercury registers mechanically its exact height at any given moment. This is effected by having connected with the float a needle-point pressing against a sheet of glass which is blackened with smoke, and carried horizontally forward by clockwork. It is evident, therefore, that the variations in height of the mercury column communicating a vertical movement to the needle, whilst the glass screen is carried forward horizontally, the resulting mark will be a diagonal varying in curvature with the variation of height of the mercury gauge. The exact height of the mercury column can, therefore, be ascertained at any desired moment.

The reservoir being filled with pure dry air at a pressure of three atmospheres, and the mercury column being stationary, the needle-point registering a perfectly straight line on the screen, a stopcock is opened and air is allowed to rush out for a certain time, say five seconds; it is then closed. As soon as the air commences to rush out, and the gaseous mass suddenly expands, its pressure diminishes, and the needle-point consequently gives a downward oblique mark on the glass plate. But in expanding, the temperature of the gas sinks, and when the stopcock is closed the remaining gas in the reservoir has a lower temperature than the reservoir itself or the surrounding bodies. The mercury gauge, therefore, stands at a lower point than it otherwise would, had the temperature remained uniform.

Upon closing the stopcock, the gas, absorbing heat from the sides of the vessel, gradually regains its original temperature, and the mercury gauge commences to raise the needle-point, registering an upward curve until the temperature is in equilibrium; it then registers a straight

* 'Comptes Rendus de l'Académie des Sciences,' February, 1864.

line once more. Another observation is now taken, and this is repeated for an indefinite number of times; the mean result being capable of any degree of accuracy according to the number of observations from which it is deduced. It will be seen that the reservoir and mercury gauge constitute a gigantic air thermometer, and the method of registration is capable of giving the most minute variations of temperature. The amount of *work* done by the sudden expansion of the gas has a fixed value in thermometric degrees, and the tracings on the glass plate hold all the data required to give the exact numerical relation between the two. We will not follow our authors into the details of their calculations, but will state from the results of their investigation, that the number 476 formerly used must be changed for that of 433, which is near that given by the labours of M. Seguin and Mr. Joule. From the method of operating, and the large scale upon which the work has been conducted, there is every probability of this number being very near the truth.

In our last Chronicles of Science we gave a short notice of a new gas-furnace by Mr. G. Gore, of Birmingham. The same principle has since been applied upon a much larger magnitude, and furnaces on a commercial scale are now in use at the electro-plate manufactory of Messrs. Elkington, Birmingham, and elsewhere. These larger furnaces, as at present constructed, are capable of melting about 400 ounces of silver, copper, gold, German-silver, or if desirable, even cast-iron. The amount of coal-gas consumed varying from 300 to 400 cubic feet per hour.

With a consumption of 360 cubic feet per hour, the following results have been obtained:—266 ounces of sterling silver were perfectly melted within 25 minutes from the period of lighting the gas in the cold furnace, and the metal was sufficiently hot to cast for rolling in 20 more minutes. A second quantity of 266 ounces of the same metal was then introduced and was perfectly melted in 11 minutes, with a consumption of 66 cubic feet of gas, value 2*d*., the price of gas being 2*s*. 8*d*. per 1,000 feet; in a further period of 15 minutes the metal was sufficiently hot to cast for rolling. A quantity (116 ounces) of German-silver was then introduced and melted in 15 minutes, and, after 28 minutes' longer heating, various highly-figured articles were cast from it in a most perfect manner. In a subsequent operation 460 ounces of silver were melted in about the same time, and with an expenditure of scarcely more gas than was required to melt 266 ounces.

The smaller sizes of this furnace are much used by dentists, jewellers, analytical chemists, assayers, enamellers, and others, in consequence of their readily fusing silver, gold, copper, glass, and even cast-iron, without the aid of a bellows or lofty chimney, by simply lighting the gas; and the crucible and its contents being at all times protected from the air and yet perfectly accessible for examination, stirring, removal, &c. The burners of the larger-sized furnaces are formed of a series of plates of cast-iron, and may be readily removed from the furnace and placed to heat a retort, muffle, reverberatory chamber, or other apparatus, where intense heat is required; it is

intended to apply them to heating steam-boilers and welding articles of wrought iron.

The safety of these furnaces, their regularity and self-supplying action, and perfect freedom from dust and smoke, render them advantageous in certain processes, such as enamelling, annealing, &c., where cleanliness and uniformity of heat are required. Their high degree of heat without the aid of a blast results from the very rapid and perfect mixture of the air and gas, and the combustion being consequently effected and concentrated in a very small space.

To provide for cases where gas is not available for the production of these high temperatures, and a more cleanly and manageable source of heat is required than that afforded by a coke furnace, Mr. C. Griffin,* has constructed an oil lamp for use with an artificial blast of air, which is not only as powerful in action as the best gas furnaces, but almost rivals them in convenience and economy. The fuel is the more volatile kind of mineral oil of the specific gravity ·750; every precaution is taken to prevent any danger of explosion by the sudden or accidental ignition of the vapour. The flame produced in this furnace is as clear as that of an explosive mixture of air and coal gas, and it is perfectly free from smoke. No chimney is required. The power of the furnace is very great: starting with a furnace quite cold it will melt one pound of cast-iron in 25 minutes, 1½ lb. in 30 minutes, 4 lbs. in 45 minutes, and 5 lbs. in 60 minutes; the cost of the latter experiment being about 9*d.* for oil. In all cases where gas cannot be obtained as a fuel for such operations, this oil-lamp furnace cannot fail to prove of very great value.

Oxygen, that fierce supporter of combustion at ordinary pressures, would have its energy increased to an inconceivable extent if used in a highly-condensed form. An observation of Dr. Frankland has shown that under this condition a solid mass of iron is almost as inflammable as phosphorus in the ordinary state of the atmosphere. During some experiments at the Royal Institution he was condensing oxygen gas into the strong iron receiver of a Natterer's apparatus, and had got the pressure up to 25 atmospheres when the vessel burst with a loud explosion, sending a shower of brilliant sparks in every direction. Upon subsequent examination it was seen that the whole of the interior of the receiver and the solid steel plugs had been eaten away to the depth of an eighth of an inch, and was covered with a fused mass of oxide of iron. The heat evolved in the compression had evidently ignited the oil used to lubricate the piston; this immediately caused the combustion of the iron which, in the atmosphere of compressed oxygen, proceeded with great intensity; there can be scarcely a doubt, the Professor considers, that had a union joint not given way, and thus furnished an outlet for the compressed gas, the latter would in a few seconds more have converted the receiver into a most formidable shell, the almost inevitable explosion of which would have scattered fragments of intensely-heated and molten iron in all directions.

The observations of Professor Tyndall on the physical properties

* 'Chemical News,' vol. ix. p. 3.

of ice, and the interest excited by his remarkable book "*Heat as a Mode of Motion*," have caused physicists in other countries to direct their attention to this subject. Professor Reusch, of Tübingen, in a letter to Dr. Tyndall,* describes some observations which he has made on this body. A long narrow plate of clean ice was suspended by its two ends in loops of silk, whilst a third loop, hung from its centre, had a small weight attached to it. After the lapse of 20 or 30 minutes a bending was plainly seen, the ice comporting itself like a plastic body; once indeed he was able to bend a thin lamella of ice between the fingers of both hands. In preparing these plates it was noticed that in sawing through ice, the saw after a time ceases to act, the space, between its teeth becoming filled with freshly-formed ice, so that it passed along almost without friction The saw, in fact, melts through the ice, the heat necessary for that being the equivalent of the work applied to the saw. In dividing plates of ice it is necessary to handle them like glass. If the convex blade of a knife be passed over a piece of ice with a certain pressure a sharp crack will result, and the plate may be broken in the direction of this crack, provided the temperature of the ice and of the air be below 0° C. Obviously the knife acts in this instance like a diamond, which depresses minute particles of glass, and through the wedge action of which a progressive linear cracking is produced, which renders fracture possible. A mere scratch suffices neither for glass nor for ice.

VIII. ELECTRICITY.

A NEW insulating material has been recently imported by Sir W. Holmes from Demerara, which bids fair to be a formidable rival to gutta-percha. It is the dried juice of the bullet tree (*sapota mulleri*) and is called balata; it appears likely to be more valuable than India-rubber or gutta-percha by themselves, as it possesses much of the elasticity of the one and the ductility of the other, without the intractability of India-rubber, or the brittleness and friability of gutta-percha, whilst it requires a much higher temperature to melt or soften it. Since the Exhibition of 1862, Sir W. Holmes, who was the Commissioner representing the colony of British Guiana, has been engaged in investigations how to produce the material cheaply, and how to dry or coagulate it rapidly; he has now succeeded so far as to warrant the importation of steam machinery to be applied for its extraction, and there appears to be every probability that balata will become an important article of commerce, supplying the great want of the day, a good insulating medium for telegraphic purposes. Messrs. Silver & Co. have already imported many tons of it, and Professor Wheatstone is now investigating its electrical and insulating properties. Another substitute for gutta-percha, the juice of the *alstonia scholaris*, a tree belonging to the natural order apocynca, has been forwarded from Ceylon by Mr. Ondaatjie; it is stated to possess the same properties, and to be as

* Philosophical Magazine,' vol. xxvii. p. 192.

workable as gutta-percha. It readily softens when plunged in boiling water, is soluble in turpentine and chloroform, receives and retains impressions permanently, and is adapted for seals to documents. These specimens are sent in response to premiums offered by the Society of Arts for the discovery of a substitute for gutta-percha.

A curious fact has been mentioned by Mr. James Napier* in reference to the dynamics of the galvanic battery, which is somewhat in opposition to the polar theory with mutual transfer of elements, advocated by Professor Williamson. Suppose a vessel divided by a porous diaphragm has dissolved in each division an equal quantity of sulphate of copper, and into each of the divisions is placed a plate of copper attached to the poles of the battery which completes the circuit; now, by the polar theory there should be a mutual transfer of the acid and copper between the two divisions, so that at any time, if the current of electricity were stopped, the solution in the two divisions would be the same as when the experiment began. But in reality this is not the case, the copper dissolved in the division attached to the zinc end of the battery will be deposited as metal on the copper plate in that division, while the acid element will be transferred to the other division. But the copper in that other division will not pass through the diaphragm in the opposite direction to the acid, so that ultimately the one division will have neither copper nor acid in solution, whilst the other division (that connected with the copper end of the battery) will have double the quantity of sulphate of copper in solution that it had at the commencement.

The electrical properties of pyroxiline paper and gun cotton have long been known to be very great, but it has only lately been pointed out by Professors Johnstone and Silliman† that these azotized species of cellulose are the most remarkable negative electrics yet observed; upon friction with these, sulphur, hitherto the most highly negative electric known, becomes positive.

We have to thank Mr. Nassau Jocelyn, of the British Legation, Turin, for drawing our attention to a novel voltaic arrangement devised by Professor Minotti, of that city, which, though essentially based upon Daniell's principle, is said to be far more constant and powerful than any other arrangement of that rheomotor. It consists simply of a copper disc placed at the bottom of a glass vessel having a gutta-percha-covered wire soldered to its rim, which issues from the top of the vessel and forms the positive electrode. Over the copper is laid a layer of powdered sulphate of copper, and over this a stratum of coarse sand, or—what has been found to answer better—a stratum one inch in thickness of common glass beads, such as are used for working purses, and may be purchased at a cheap rate at the workshops. On this layer lies a solid cast-cylinder of zinc, from whence proceeds the negative pole of the element. On the cell being filled with common spring water, so as to cover the zinc, the battery begins to work, and will keep constant and uniform for seven or eight months. The intensity of

* 'Philosophical Magazine,' vol. xxvii. p. 52.

† 'Silliman's Journal,' January, 1864.

the action may be judged by measurement with the galvanometer, which will be found in a cell where the copper and zinc surfaces are about 3 inches square each, to have its needle deflected to about 20°. This is in the case of the meter ordinarily employed by telegraphists. The power may be increased by approaching the elements of the cells nearer to one another, by placing the copper *over* the sulphate, and by reducing the beads to half an inch. There is, however, danger in this case of the accumulating surface of copper on the copper plate, crystallizing in an upward direction, and ultimately shooting out a fibre which may touch the zinc plate above it, when of course the cell would cease to work. The first arrangement is the best, and it is the one which M. Bonelli has adopted in working his new telegraph. The above battery appears to be the simplest yet brought before the public, consisting as it does of easily procurable materials, and its action being only limited by the waste of zinc and evaporation of water. M. Bonelli uses 30 cells to work his five-wire telegraph for a long distance, so that 6 cells appear amply sufficient per wire.

IX. PHOTOGRAPHY.

Iodide of silver may be looked upon as the foundation of the present photographic art, and yet up to a very recent period, men of science have differed in their opinion as to whether this compound is photographically sensitive *per se* or not. As late as January last, we find a foreign photograher, M. Gaudin,* publishing some experiments which tend to show that iodide of silver, when prepared by the direct combination of iodine and silver-leaf, is absolutely insensitive to light when tested under a negative, and that an hour's exposure in the printing frame does not give rise to any impression whatever, either before or after the application of a developing agent. The iodide of silver used in these experiments was in the form of a yellow powder, rather unctuous to the touch, and was merely rubbed over the surface of a piece of paper with a tuft of cotton. Subsequent experiments were tried in which the iodide of silver, after being rubbed over the paper, was exposed to the vapours of nitric acid, hydrochloric acid, and ammonia: the last only gave signs of a picture, and that only after a very long exposure. These experiments tend to confirm what is generally stated in chemical works; but Mr. Spiller † has since communicated some further results, tried with that care and ingenuity which are so well known to those who are familiar with the published researches of this chemist, which show conclusively that iodide of silver exists in two different modifications, one of which is insensitive, whilst the other is sensitive to the action of light. Reasoning upon the well-known change which takes place when iodide of mercury is heated—its scarlet colour changing to yellow—it occurred to him that a similar change might possibly be induced in the iodide of silver. This

* 'The Photographic News,' vol. viii. p. 8. † Ibid. vol. viii. p. 15.

was confirmed by experiment, and by the application of heat alone the indifferent yellow iodide of silver becomes so changed in its properties, as afterwards to darken on exposure to sunshine much in the same way as the ordinary modification of bromide of silver. Very little apparent change is produced by the action of heat; at the most, the iodide can be said only to lose in a trifling degree the brilliancy of its yellow colour, verging a little towards grey. The lowest limit of temperature at which this change takes place is 350° Fahr.; and if the heat be augumented to 400° and upwards, the change is more rapidly effected. On increasing the heat, the iodide fuses to a dark-red fluid, which cools to a pale yellow semi-transparent mass, quickly affected by exposure to light.

Photographers are gradually recognizing the truth of what Sir William Newton urged more than ten years ago, namely, that it is possible to have pictures too sharp, and that the most artistic portraits were frequently those which were not absolutely in focus. One of our first writers on Art Photography has lately urged, in the 'British Journal of Photography,' the beauty of effect arising from slight want of sharpness. What artists call "hardness," is generally that effect which photographers call "sharpness;" and he maintains that far more pleasing portraits would be obtained were photographers to use their "long, long pencils of light much as artists use their drawing pencils,—that is to say, with a somewhat broad instead of an extremely sharp point." Although to an ardent photographer such doctrines may savour of rank heresy, we honestly confess that we have seen far more pleasing portraits taken in accordance with this artistic theory than when they were focussed with microscopic accuracy.

A writer in 'La Lumière' proposes a novel lantern for evolving light sufficient for taking portraits at night. A furnace is constructed, fed with hard retort carbon, and supplied, not with air alone, but with a mixture of oxygen and air: the oxygen being evolved from a mixture of binoxide of manganese and chlorate of potash, contained in a cast iron bottle placed beneath the furnace. In a small furnace furnished with a good draught, and only supplied with air, a light was obtained equal to 100 candles, and the author thinks that if fed with oxygen, the light would be equivalent to 1,000 candles. We do not glean from his description that such an experiment has been actually made, and we are tolerably confident that the difficulties in its practical accomplishment would prove too great to supersede other sources of artificial light, which have been recently introduced.

The Electric light has always been a favourite amongst advocates of night photography. At a recent meeting of the American Photographic Society, Mr. J. A. Whipple, of Boston, exhibited some photographs of a fountain in Boston Common, taken at about ten o'clock in the evening, whilst illuminated with the electric light. The exposure was 90 seconds, and from a comparison of the effect produced when photographed in daylight, it was estimated that the intensity of the electric light as compared with that of weak sunlight, was in the pro-

portion of 1 to 180, half-a-second only being necessary to produce a similar picture in the daytime.

The electric light, hitherto without a rival, is likely to be equalled in brilliancy, and far surpassed in convenience and cheapness, by the magnesium light. In our chronicles of the progress of optical science, we have given an account of this truly wonderful light, and we have to add here some notes respecting its photographic value. At a late meeting of the Literary and Philosophical Society of Manchester,* Professor Roscoe exhibited some prints of a portrait which Mr. Brothers and he had taken at 5 o'clock p.m., on the 22nd of February, by burning 15 grains of magnesium in the form of fine wire at a distance of about 8 feet from the sitter. The negative thus produced was stated by Mr. Brothers to be fully equal to any obtained by sunlight in the most favourable state of the atmosphere, and the distribution of light and shade was most agreeable, harshness of the shadows being completely avoided by slightly moving the wire whilst it was burning. The magnesium was worth about sixpence. Photographers are now eagerly asking for supplies of this metal, and if the wire can be got for anything like a reasonable price, there is no doubt that in this climate, at all events, this application of it is likely to inaugurate a new era in the photographic art.

A very ingenious application of Professor Graham's discoveries in the diffusion of liquids has been just made by Mr. Spiller. In washing photographic prints it has been noticed that the first portions of hyposulphite of soda are easily extracted, whilst the last portions are only removed from the paper with great difficulty. This is explained by the great diffusive power into plain water of a strong solution of hyposulphite of soda over a weak one. After the first portions of hyposulphite have been removed from the print, Mr. Spiller† proposes to transfer them into a cold saline liquor made by dissolving a pound of salt in half-a-gallon of water; they are left there for fifteen or twenty minutes, when it is found that the salt brine has thoroughly penetrated the pores of the paper, and expelled the greater part of the remaining hyposulphite. The liquid is then poured away, and the prints are washed in common water. The principle of diffusion now comes into play again, and the salt brine rapidly soaks out of the paper, bringing with it the last traces of hyposulphite; by finally washing in the ordinary manner, an unusual degree of purity is attained, the presence of hyposulphite in the finished proof being rendered impossible. This is one of the most beautiful applications of a recondite scientific principle which we have ever seen.

The detection of hyposulphite of soda in the finished proof, or in the last washings, is a matter of some importance. Mr. E. J. Reynolds has communicated to the 'British Journal of Photography,' a series of experiments on the various methods at present in use. The first consists in reducing the hyposulphite to the state of sulphide by boiling

* 'Proceedings of the Literary and Philosophical Society of Manchester,' No. 13, p. 241.

† 'The Photographic News,' vol. viii. p. 113.

first with acid, then with alkali, and then adding nitro-prusside of sodium; this communicates a beautiful violet colour. The next consists in adding sesquichloride of iron, which at once gives a purple red tint if hyposulphite be present. The third test consists in adding iodine and starch, the blue colour of which is immediately discharged on the addition of a few drops of a solution containing a minute trace of hyposulphite. This reaction is very delicate, as it is capable of detecting one grain of the salt dissolved in $2\frac{1}{4}$ gallons of water. The fourth mode of detecting hyposulphite is based on the property which it has of reducing sesquichloride of iron to the protochloride. The suspected liquid is boiled in a small flask, with four or five drops of the iron solution, and a drop of red prussiate of potash is added. If hyposulphite be present, a blue precipitate or coloration is produced. This will detect one grain of the salt in four gallons of water. The fifth and most delicate test of all is obtained by introducing a few drops of hydrochloric acid, and a fragment of zinc into the suspected liquid, and testing the evolved gas for sulphuretted hydrogen by means of lead paper. This is so sensitive that it will detect one grain of hyposulphite in rather more than seven gallons of water. For the purpose of detecting any hyposulphite in the finished picture, the plan adopted by Mr. Spiller is the most convenient; he moistens the white parts with a little protonitrate of mercury, when the presence of even a trace of hyposulphite is shown by the production of a brown or black stain.

Few things are falsified more than the chloride of gold and the aurochloride of sodium used by photographers for toning their prints. The usual adulterant is common salt, which is sometimes added in such quantity that a bottle professing to hold seven grains of gold sometimes contains only a little over two. The editor of the 'Photographic News' has published a very simple mode of detecting this adulteration. Both the chloride of gold and aurochloride of sodium are soluble in alcohol, whilst chloride of sodium is insoluble in that liquid. The photographer has, therefore, only to stir up the contents of a fifteen-grain tube with alcohol, and the amount of white crystalline residue will show how much common salt has been sold to him at the price of gold.

M. Quaglio, an engineer of Vienna, has investigated the properties of oleate of silver, or silver soap, in photolithography. After some preliminary preparation, the lithographic stone is covered, with the aid of a flannel rubber, with the silver soap, and it is then exposed under a negative to the sun. The portions unacted upon are then dissolved out with naphtha, and the stone is ready to be gummed and inked in in the ordinary way. This process is extremely easy and appears likely to be successful. The impression is obtained direct from a negative, a transparent positive not being required, as in some other processes.

The substitution of a less expensive metal for silver has been the dream of photographers for many a year. M. Liesegang describes, in the 'Moniteur de la Photographie,' a process devised by M. Obernester, of Munich, which seems to be very successful. The paper is first washed

with a mixed solution of sesquichloride of iron and chloride of copper. The paper after drying is ready to be exposed in the printing frame; its sensitiveness is one-third greater than that of albuminized paper. Very little is seen on removing it from the printing frame, but it is partially developed by floating it on a solution containing sulphocyanide of potassium and a little sulphuric acid. The effect of this is to precipitate white subsulphocyanide of copper, upon those parts of the paper upon which the light has acted. After washing for an hour or two, the picture can be obtained of different colours by dipping it into appropriate solutions. Thus, red prussiate of potash gives them an intense red hue; by acting on this with an acid solution of iron they become violet red, violet blue and black, and after coating them with albumen, it is impossible to discover any difference between them and the best silver proofs upon albuminized paper.

X. ZOOLOGY AND PHYSIOLOGY.

The French Academy, whose annual meeting took place at the close of the year, occupied itself with a tribute to the distinguished and lately deceased zoologist, André Dumeril, and then proceeded to announce the prizes which it proposed to offer for the coming year, by means of which it may be hoped new impulse may be given to the various departments of science. The great Physical Science Prize of 3,000 francs has been postponed from 1859 to 1st of September 1864; the subject is "The Comparative Anatomy of the Nervous System of Fishes." Another prize of the same value has been postponed from 1861 to December 31st 1865; the subject is, "The Production of Hybrid Animals by means of Artificial Fecundation." A third prize of 3,000 francs is offered for the osteographical work which will best contribute to the advancement of French palæontology, to be sent in by 1st of November 1865. The Cuvier prize, to be awarded in 1866, will be given to the most remarkable work upon the Animal Kingdom, or upon Geology. This prize is awarded every three years,—the funds arising from unemployed subscriptions to the statue of Cuvier; it has just been awarded to Sir R. Murchison for his works upon the Palæozoic formations. Another Cuvier prize is also announced to be given to the author of the most remarkable work upon the Animal Kingdom, or on Geology, which shall appear between the 1st January 1863 and the 31st December 1865. The prize to consist of a gold medal, value 1,500 francs. Another prize, termed the Godard prize, of 1,000 francs, is given annually to the best paper on a physiological subject, which is this year left open.

Although some of these prizes, owing to the extended character of the researches required, have been necessarily postponed from year to year, it is not therefore to be supposed that there are no competitors, or that this stimulus is offered in vain. Other prizes of a similar character were awarded at the meeting of the Academy, as the first

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prize in Experimental Physiology, which was given to M. Moreau, for a work "On the Air-bladder of Fishes," while a second was given to MM. Philippeaux and Vulpian, for some "Researches on the Reunion, end to end, of Nervous Sensitive Fibres with Nervous Motor Fibres." The second Bourdin prize was unanimously awarded to M. Lacaze Duthiers, for his anatomical and physiological history of coral, and other zoophytes.

The practice of vivisection in Paris, which has received so much public notice of late, has recently been brought before the French Institute. It will be recollected that a visit was made to the Veterinary College at Alfort, by delegates from the English Society for the Prevention of Cruelty to Animals, and the adhesion of the Director of that Institution, so notorious for its torturing practices, was secured. The Emperor also promised the deputation that he would institute a scientific commission into the subject, and that promise he has kept, though the result appears not to have been unmixed good. M. Robin, formerly an opponent, has become a violent partisan of the practice of vivisection. In anticipation of the struggle about to take place between the advocates of the two systems, a regular correspondence has been opened between the different Academies of Europe, and the opinions of scientific men of all countries are eagerly collected. The first communication, recently made to the Institute, was from Professor Lusana, of Pisa, who described the processes by which he had succeeded in extracting the pneumo-gastric nerve from dogs and rabbits, after numerous attempts. The result of this frightful operation appears to be that the victim becomes insensible to the strongest poisons, and that even strychnine may be introduced into the stomach with impunity. But however curious and interesting this fact may be to the physiologist, we cannot see that any very practical results may be drawn from it; and we trust that the more humane physiologists who engage in the controversy, may not be dazzled by the spurious brilliancy of such a discovery into the reprehensible practice of systematic torture of dumb animals.

The period of gestation of certain animals of the class of Ruminants, which habitually breed in the Zoological Society's menagerie, has been ascertained with tolerable exactness by Dr. Sclater, the Secretary. Of course the period is slightly variable, but the times given in the following list are, on the average, very faithfully adhered to.

Fam. *Cervidæ*.—The following have a period of eight months: Wapiti Deer (Cervus Canadensis), Persian Deer (C. Wallichii), Barasingha Deer (C. Duvaucelii), Japanese Deer (C. Sika), Sambur Deer (C. Aristotelis), Rusa Deer (C. Rusa), Hog Deer (C. porcinus), Axis Deer (C. Axis).

Fam. *Camelidæ*.—Llama (Auchenia glama), and Alpaca (A. pacos), both have a period of eleven months.

Fam. *Camelopardidæ*.—Giraffe (Camelopardalis giraffa), fifteen months.

Fam. *Bovidæ*.—Punjaub wild sheep (Ovis cycloceros), and Moufflon (O. Musimon), each four months; Leucoryx (Oyx leu-

coryx), eight months; Eland (Oreas Canna), nine months; and Nylghai Antelope (Portax picta) between eight and nine months.

The Hippopotamus has twice produced young in the Amsterdam Gardens.—on the first occasion she went seven months and sixteen days, and on the second seven months and twenty days.

Mr. Sherbrooke Walker, who has lately come from New Zealand, brought with him some fine bones of the Moa (*Dinornis giganteus*, Owen), which he has deposited in the Liverpool Museum in very perfect condition. They consist of right and left femur, two left tibiæ, two left metatarsi, and two vertebræ. These bones were found in a limestone cave at Blue Cliff station, in the province of Canterbury, to enter which the explorers had to let themselves down by a rope, and crawl in on their hands and knees. Mr. Walker reports that the Maories assert that formerly the Moa was very numerous, and used to kill the native children, so that they at length determined to exterminate the birds, and to burn the island for this purpose; and, according to them, on a day fixed upon, the whole of the east coast was fired at the same time. Whether this be true or not, it is very evident that all the east side of the middle island was once heavily timbered, for go where you will, on hills or plains, you will find large burnt logs of a species of pine, called by the natives *Totara*, which never decays in the ground; and also, more rarely, logs of a species of cedar, now extinct there. These logs are only charred on the outside. Wood, however, still exists on the island which may have been protected by a swamp or river, in which swamps Moa bones are sometimes found, as though they had found shelter there. Mr. Walker is incredulous of this Moa still being existent on the island, and only heard of one person who professed to have seen one, when a child. The Maories also have a tradition that these birds used to go into caves, and that their ancestors made large nets of New Zealand flax (*Phormium tenax*) for the purpose of catching them for food.

Mr. Walker describes the habits of another remarkable New Zealand bird, the Owl Parrot (*Strigops habroptilus*, G. R. Gray), called *Rakapo*, by the natives, found chiefly in the Middle Island. It is about the size of a common hen, with a varied black and green plumage, evidently a nocturnal bird, always hiding itself under some thick plant in the daytime. It cannot fly at all, and has a very singular mode of progression, giving a hop forward, and then putting its head down, and resting its forehead on the ground. Mr. Watts Russell, who has had frequent opportunities of observing these birds in their native haunts, confirms this singular account of their using their head as a third foot. It is entirely a ground bird, and in appearance singularly resembles an owl.

While on the subject of Struthious birds, of whch the Moa was a grand type, it may be mentioned that Professor Hincks, of Toronto, in a paper recently published on their systematic relations, remarks that those who have arranged them among the Rasores have been guided by real and important analogies—those who have placed them among Grallatores have attached undue importance to a single character, which really only indicates the position of this in reference to

the other families of Rasores—and those who have elevated this group to the rank of one of their great orders of birds have chiefly manifested their hesitation between the other two views, by taking a sort of intermediate position. The position of Apteryx, that most remarkable New Zealand bird, as a type of a sub-family of Struthionidæ, seems to be conceded; and its long, narrow beak, with the nostrils at the extremity, is so especially tenuirostral, that there can be little doubt about its fittest place, though its entirely suppressed wings and hair-like feathers might seem to mark it as last in the circle, because lowest in development.

Captain Mitchell, of the Madras Museum, confirms the accounts of the climbing habits of the fish, *Anabas scandens*, and asserts that it *does* ascend the palm-trees, suggesting that as it does so after heavy monsoon rains, it may be that it prefers pure rain-water to the muddy water found in the pools and streams at those times. The native assistant at the Madras Museum states that he has *seen* them climb. He says:—"This fish inhabits tanks or pools of water, and is called *Panai zéri*, *i. e.* the fish that climbs Palmyra trees. Where there are Palmyra trees growing by the side of a tank or pool, when heavy rains fall, and the water runs profusely down their trunks, this fish, by means of its opercula, which move unlike those of other fish, crawls up the tree sideways to a height of from five to seven feet and then drops down. Should the Anabas be thrown upon the ground, it runs or proceeds rapidly along in the same manner (sideways) so long as the mucus on it remains." This sideways movement, by inclining the body considerably from the vertical, enables the fish to use the spines on the operculum to the best advantage. The operculum itself is remarkably movable, and the locomotion is described as a wriggling one. Other observers have satisfied Captain Mitchell that they have seen the Anabas ascend Palmyra trees at Negapatam and in the neighbourhood of the Red Hills, in the vicinity of Madras.

M. Moreau arrives at the following conclusions relative to the air in the swimming-bladders of fishes:—This air presents a composition which may vary more or less, relatively to the proportion of oxygen under the following circumstances: 1. The oxygen diminishes and disappears in asphyxia and other morbid conditions. 2. In fishes with an open, as in those with a closed, swimming-bladder, the air is renewed without being derived from the atmosphere, and the rapidity of this renewal is in proportion to the vigour of the fish. 3rd. The new air presents an amount of oxygen far superior to the proportion of gas usually contained in the air of the swimming-bladder, and also far superior to that contained in the air dissolved in the water.

The Entomological Society of New South Wales in the first part of its Transactions lately published, gives a description of an ovo-viviparous moth of the genus Tinea, which he calls *Tinea vivipara*. It was captured after dark early in October, and fearful that the plumes might be injured by its struggles, it was gently compressed, and on opening the hand Mr. Scott observed numbers of minute, but perfect

larvæ being ejected from the abdomen in rapid succession, and moving about with considerable celerity, evidently in search of suitable food or shelter. Several other specimens were subsequently obtained, and they shortly commenced to deposit their living progeny with rapidity, the small white fleshy larvæ being seen with great distinctness on the black surface of the paper, affording satisfactory proof that this insect, the only one of the order at present known, is unquestionably ovo-viviparous, and will represent in future this peculiarity among the lepidoptera, similarly to those few species existing in the hemipterous and dipterous orders.

The Boston Natural History Society have had an account laid before them of the operations of the minute *Platygaster*, which attack the eggs of the *canker-worm moth* (Anisopteryx vernata). Mr. Scudder, the observer, states that after moving round a long while in search of a suitable place to lay its eggs, using its ovipositor as a feeler, the abdomen is plunged down into the space between three continuous eggs, and the ovipositor perforates one of them, out of view. The body of the insect assumes a position perpendicular to its exposed surfaces, supported in the rear by the wings, which, folded over the back, are placed against the surface behind, while the hind legs, spread widely apart, sustain the insect on either side, and the middle pair are placed nearer together in front. With the four legs dangling it remains motionless, except some slight movement of the antennæ, for three or four minutes, after which it moves off, seldom flying, in search of another place.

At a recent meeting of the Entomological Society a communication was read from the Lords Commissioners of the Admiralty, enclosing a copy of a circular letter from the Governor of St. Helena respecting the ravages committed in the island by the white ants. It was stated that they were (it was supposed) accidentally introduced from the coast of Guinea twenty years ago, and now almost every dwelling, shed, store in Jamestown, containing 4,000 inhabitants, have been seriously injured by them, involving in many instances complete ruin and abandonment, and imperilling the lives of large numbers of the poorer classes, who are still living in houses of doubtful security. The Governor was anxious for information as to the most successful mode of finding the ants' nests, and effectually destroying their receptacles, and as to the description of timber which had proved to be least susceptible of injury from the insects, and the average market price of such timber per cubic foot General Sir John Hearsey stated that if ever ants effected a lodgment in the walls of a house. the walls themselves must be taken down before the insects could be eradicated. He thought the best preventive was to steep the timber before building in a solution of quicklime, and completely saturate it therewith; whilst store-boxes, furniture, and small articles should be painted over with a solution of corrosive sublimate. Mr. Bates coincided with General Hearsey in his estimate of the value of quicklime. The nests must be sought for in the plain. Mr. E. W. Robinson said that on the Indian railways creosote was applied to the sleepers—but it was not sufficient merely

to coat them with the solution, but the whole block must be impregnated with the solution by hydraulic pressure.

Dr. J. D. MacDonald has communicated to the Royal Society of Edinburgh a memoir on the morphology of the tunicated mollusca, in which he considers that the fixed tunicates exhibit at least two well-marked types, and the free Pelagic group four, which are equally distinct and of equal importance. He also considers that very striking representative relationships exist between the fixed and free tunicates, as, for example, between *Appendicularia* and *Pelonaia,—Doliolum* and the remaining simple tunicata, Salpa representing the social, and Pyrosoma, the compound group, especially the Botryllians.

Professor Allman has just pointed out a curious and important character of the so-called nemataphores in the plumularian zoöphytes, hitherto unnoticed. In *Plumularia cristata* he finds them to consist of a true sarcode or protoplasm, and except in the fact that the protoplasm contains a cluster of thread cells immersed in its substance, it appears in no respect to differ from that which constitutes the substance of an amœba. This soft granular mass has the power of projecting extensile and mutable processes, consisting of a finely granular substance which undergoes perpetual change of form, comporting themselves in every respect like the pseudopodia of an amœba, which they also resemble in their structure, for they consist of a simple protoplasm composed of a transparent semifluid basis, in which minute corpuscles are suspended. In *Antennularia antenninia,* a genus possessing the closest affinities with *Plumularia,* entirely similar phenomena have been witnessed, the processes being usually simple, in only one instance there having been seen what appeared to be a short irregular branch given off from the finger-like pseudopodium.

M. Lacaze-Duthiers, who, we have observed, has obtained the Bourdin prize for his inquiry into the anatomy and physiology of corals, has produced a monograph of 371 pages, accompanied by another of 20 pages, comprising 120 figures relating solely to corals. He describes and draws in detail the reproductive organs, male and female, and has studied the development of the eggs, spermatozoids, and larvæ; has observed the larvæ during their period of liberty, determined the first signs of their future transformation, and followed this transformation step by step to the moment when the single being issuing from the single egg, begins to shoot, and gives birth successively to a whole colony, of which it is the actual parent. These facts are all new. Coral does not present the phenomena of *alternate generations,* established among so many other Radiata; still it enters none the less into the category of *geneagenetic* animals, as they are termed by M. de Quatrefages. The *scolex* alone undergoes a real metamorphosis. In general the sexes are distinct in corals, but one may occasionally find on a male stem a branch where the polyps are female, and *vice versâ.* A branch may also contain individuals of both sexes, and more rarely still the same individual may be both male and female. Thus, regarding the separation of the sexes, the coral zoöphytes present the two extremes and almost all the intermediate degrees.

M. Duthier's experiments are still in progress on the coast of Algeria, where he is endeavouring to determine the rapidity of growth of the coral, by immersing at a certain point 150 large jars marked so as to be recognizable, which, successively taken out, will furnish information on the development of the calcareous axis hitherto unknown.

The expedition led by the Rev. H. B. Tristram for the scientific exploration of the Holy Land was early in January at Jericho investigating the natural products of the valley of the Jordan, which offered abundant promises of fruitful results. The preceding month had been spent in the more barren field of inquiry between Beyrout and Jerusalem. In the Jordan valley a new fauna was found to prevail, essentially different from that of the high land, and surpassing all previous expectations as regards its abundance, if not as regards its variety. The expedition proposes to pass the summer in the highlands of the Lebanon and surrounding district, and to return home in the autumn. The Government-grant committee of the Royal Society have recommended a grant of 50*l.* to Mr. Tristram in aid of the expedition.

A somewhat singular scientific expedition round the world has been organized by Austria. The *Marco Polo* was to leave Trieste on the 5th March, taking with her about 60 passengers, who were each to pay 400*l.* passage money, and the voyage was expected to extend over eight months. The actual voyage was calculated to occupy about 200 days, and 50 days were to be spent in visiting 30 different ports which had been selected as stopping places. The vessel has been fitted out with scientific apparatus of all kinds.

The French, not behindhand, are organizing an expedition to Mexico, which will probably be productive of useful results. This will be under the auspices of the Minister of Public Instruction, M. Duruy. He recommends that a sum of 8,000*l.* should be set apart to defray the expenses of the expedition, and his suggestions have been approved by an Imperial decree appointing the members of the commission. Among them are Marshal Vaillant, Baron Gros, Michel Chevalier, Vice-Admiral Jurien de la Gravière, Milne-Edwards, Baron Larrey and Viollet le Duc, M. de Quatrefages, &c.

REVIEWS.

THE STORY OF THE GUNS.*

With the din of war approaching nearer to our shores, and the political horizon assuming a more and more threatening aspect, it is no wonder that the 'Story of the Guns' should have been the book of the past quarter.

From the 'Natural History of Ceylon' to the subject under consideration is, indeed, a great leap, and there are few men living who could have accomplished it more easily than Sir James Emerson Tennent; but it would be alike unfair to our readers, and to the author himself, if we were to speak of this work in the same terms of unqualified praise as of his former labours. Whether it has been his intention, in the performance of what he may have conceived to be an imperative duty, to expose facts with which he considers that the nation should be made acquainted, namely, the extravagant and unwarranted expenditure of money upon an imperfect weapon, or whether it was simply his desire to reinstate in public favour a gentleman of rare abilities whom he believes to have been neglected and slighted by our Government, we are, of course, unable to say; but however honest may have been his intentions, we can assure him that he will have failed in creating the desired impression upon the minds of his careful readers.

A book emanating from such a source, and appearing at so opportune a period, could not fail to command attention, and the journals requiring literary extracts as a portion of their daily bread would necessarily increase its popularity and renown. But then come the thinkers, the men who read a work not with a view to ascertain what it says, but what it means; many of them, perhaps, with as strong a bias as the author himself, but in the opposite direction; and to these the book has been in a great measure a disappointment, for it is rather a story of the grievances of one gun manufacturer, and a disapproval of the favouritism shown to another (who received his appointment under a ministry professing political views which were until recently believed to be opposed to those of the author), than what it professes to be, namely, a history of our scientific progress in the manufacture of guns and rifles. And whilst we were toiling wearily through the narrative of Mr. Whitworth's wrongs and of Sir William Armstrong's unwarranted promotion, couched in language whereof it is difficult to say which of three qualities it best conceals—official caution, the pungency that characterizes the lower house, or the polite conventionality

* 'The Story of the Guns.' By Sir James Emerson Tennent, K.C.S., LL.D., F.R.S. Longmans.

of "another place,"—we could not help feeling that if ever a cause had been lost by too much pleading, it was in the case before us.

It matters not how true every alleged fact may be, there is from beginning to end of the work such a palpable *animus*, and the same statements and contrasts are so frequently reiterated to the prejudice of Sir William Armstrong, and dwelt upon so significantly, that a great portion of what should have given scientific interest to the work is completely cast into the shade by the political attack.

Having thus given expression to our discontent at the author's mode of treating this portion of his subject, and acting, as we believe, with more generosity than if we had retailed any of the episodes in the story of the *Gunmakers* which he has published, we proceed to glance rapidly over the contents of the volume. The first part of the work is devoted to the history of the musket and rifle, commencing with "Brown Bess," and closing with the triumph of the "Whitworth" over the "Enfield." Although, of course, the work refers rather to the past of the Enfield rifle than to its present state, it being described not as it is, but as it was, we have some very interesting comparisons between the early performances of the two weapons last named; and these have been illustrated very effectively by drawings of two targets, which exhibit the relative shooting made by the two rifles.

Let us mention, in passing, that we have seldom seen a work so admirably illustrated, the subjects for illustration being so well selected, and the execution so perfect, that explanations are hardly requisite, and a glance over the plates suffices to afford a good idea of the recent development in the fabrication of arms of offensive warfare. The bullet-marks on the Enfield rifle target are scattered about in every direction, many of them touching the very edges of the target, and very few approaching the centre; whilst in the Whitworth target, every mark is within one of the four central squares (there are in each target 20 shot-marks, and 42 squares), and many of them impinge upon the centre lines of the target.

From the consideration of small arms, the author passes, in his second Part, to that of ordnance, and here again we have a most interesting and graphic description of the various guns which have either had their hour and have passed away, or which are still in use here or elsewhere; amongst English rifled guns we have an account of the "Lancaster," "Whitworth," "Bashley Britten," "Lynall Thomas," "Jeffery," "Hadden," "Scott," and "Armstrong," with sections of all but the two first inserted on two opposite pages to exhibit their respective systems of rifling. Reference is made, too, to the French "*canons rayés*" and to the monster gun forged by the Mersey Steel Company at Liverpool. This gun weighs above 24 tons, and discharges a spherical ball 300 lbs. in weight; and some idea may be formed of its effect, by a reference to the frontispiece which represents the famous "Warrior Target," and exhibits the havoc made on it by this gun, as compared with the Whitworth. The remainder of the second part is taken up with the history of Sir William Armstrong, Mr. Whitworth, and their respective inventions; and we are told by the author that the mode of dealing adopted towards inventors by the State and the official appointment

of Sir William Armstrong have rendered any considerable improvement in our offensive arms a matter of great difficulty. For although Sir William has resigned his appointment, and therefore leaves the Government free to deal with whom it likes, our author tells us that the outlay which has already been incurred "operates practically as a bond by which, under a penalty of two millions and-a-half sterling, the country is deterred from attempting any change." *

Before finally passing away from the question of the "contest," we will say that it leaves this impression upon the mind of a disinterested reader. One cannot help regretting that Sir William did not act more consistently after he had "made a gift" of his invention "to her Majesty and her successors without any pecuniary or other valuable consideration;" or that, instead of laying himself open to the imputation of having *given* his gun for a purpose, he did not require 50,000*l.* or 100,000*l.* for so great and valuable a safeguard to his country. But, on the other hand, when we are told that a man of known repute, who had been in constant communication with the Government, is suddenly thrust aside when his services are most needed and on a pressing emergency, and another comparatively unknown is preferred before him for a duty of immense responsibility, we cannot but feel that there must have been some shortcoming, some want of energy and promptitude, which caused his rival to be taken by the hand. Whether or not we have formed this opinion without a sufficient basis, our readers will have an opportunity of judging when we come to speak of more recent experiences than those referred to in the volume before us.

The Armstrong gun has been a very dear experiment, but it was rendered much more costly by the dispatch that was requisite in order to atone for the previous apathy of the Government; and it is impossible to say what dangers have been averted from our shores through the energy and promptitude of the man to whom the task of strengthening our means of defence was confided. Let us, therefore, not spurn the bridge that has carried us safely over our difficulties.

In speaking of the "Iron Navy" in the remaining portions of his work, the author tells us of the early failures of the most powerful guns to project a missile through the plated sides of a man-of-war. He refers to the valuable services of the Iron-plate committee, of whom one of the ablest and most useful members is Dr. William Fairbairn, of Manchester, and to the results attained through the experiments of that committee, the progress of the offensive and defensive art being traced to the time of his going to press.

Finally, he closes a work which, in spite of its serious defects, is destined to take its place amongst our standard books of reference in this branch of science (its tone and method frequently reminding us of the labours of the late respected minister of war, Sir George Lewis), with an admirable and scholarlike peroration, wherein he recommends the admittance of all deserving inventors into the ranks of competitors

* How much more is this, we would ask the author, than it cost us to *prepare* for the defence of Canada during the 'Trent' affair.

for the supply of arms to the State, and winds up with the patriotic declaration that "the abiding interests of the country will henceforth require that the man who reaches the high eminence of giving his name to the arms under whose protection the nation reposes, should hold it by no other tenure than that of uncontested superiority." And we trust the author will permit us to add, that the triumphant candidate may rest assured that his services will be as highly esteemed by the nation as are those of the man who, through the prompt application of an arm which he acknowledges to be imperfect, did much, at a period of pressing danger, to save his country from a serious infliction, and who at the present moment takes a very high rank amongst the scientific men of his country.

There are three conditions which our manufacturers of ordnance and of iron are endeavouring at present to fulfil, in order to secure a gun that will have a reasonable chance of success in action.

First, a sufficiently extensive range, with accuracy of aim; secondly, convenient proportions; and thirdly, a suitable projectile.

For an attack upon forts, especially where these are rendered unapproachable through natural or artificial obstacles, or *where the attack if made without due care, might involve the destruction of property or life which it would be desirable to spare*, the first condition is indispensable, and the author of the work we have just noticed tells us that Mr. Whitworth's rifled ordnance has carried off the palm in this respect, one of his 12-pounder guns having projected a shot nearly six miles. We believe that no new feature of importance has transpired in this respect since the work was published, and we therefore pass on to the consideration of the second and third objects.

Until very recently the greatest desideratum has been, and we believe at head-quarters it is still, to obtain a convenient "broadside gun" which can be easily managed in a heavy sea, and will do execution at between 200 and 2,000 yards against an enemy similarly armed and heavily plated. Such guns we have in our 68 and 110-pounders, and here again Sir James Tennent awards to Mr. Whitworth the credit of having constructed the *first* that could send a shot through armour-plate 4½ inches in thickness. This he effected with an 80-pounder gun, a charge of about 12 lbs. of powder, and a cylindrical bolt of "homogeneous metal," driving his shot at a range of 200 yards, through the armour-plate of the 'Trusty,' a vessel specially devoted to such experiments.*

But now we have a hint from the heads of the departments as to the cause of the want of co-operation between Mr. Whitworth and

* We are however informed by a good authority, that the first gun which ever penetrated a thick armour-plated target was made at Liverpool for the United States Government. This gun projected a missile which (in America) pierced a target plated to the thickness of 6 inches, and built up of ½-inch plates. The backing was 3 feet of solid oak, which the missile also penetrated, lodging in it so deeply that it was never recovered. The gun weighed 7 tons 17 cwt.. with a bore of 12 inches, and carrying a spherical shot of 212 lbs. Mr. Whitworth's gun and the "Monster gun" were subsequently tried on the same day at Liverpool, and we believe that both were equally successful.

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themselves. During a recent discussion in the House of Lords, the Earl of Hardwicke referred to this gun,* and recommended that such guns should be supplied to the service. The reply of the Duke of Somerset was that they had been anxious to have such guns, but that Mr. Whitworth was not able to deliver them, and subsequently Earl de Grey and Ripon informed the House that a committee was appointed in 1863, on which Sir William Armstrong and Mr. Whitworth were respectively represented; that the instructions of this committee were shown to both gentlemen, and that a certain number of guns was ordered from each competitor.

"The guns so ordered were 12-pounders and 70-pounders. In a short time the 12-pounders were delivered, but Mr. Whitworth's 70-pounders had not been sent in yet, and from the time when it closed its evidence the committee had done nothing except repeatedly calling upon Mr. Whitworth to produce his 70-pounders. That was the reason why the inquiry had been stopped. Mr. Whitworth himself accounted for the delay by alleging the difficulties he experienced in getting the steel which he required."

The supporters of the gentleman last named maintained until recently that it was only a shot such as we have described, a flat-fronted cylindrical bolt of homogeneous metal, which would penetrate armour-plates of great thickness, and as far as the substance is concerned their views are pretty accurate. Indeed in the debate just referred to, the Duke of Somerset is reported to have said, that "if they fired with a cast-iron shot, the effect was trifling. Indeed they might almost as well fire mud at the target, unless the projectile was of a very hard substance." And he further told their lordships that "no sooner had they obtained a hard projectile than not only Mr. Whitworth's, but Sir William Armstrong's gun would fire a shot that would penetrate an iron plate."

He referred also to an experiment that had been tried a few days previously, and of which the details were published in 'The Times.' They prove most satisfactorily that the form of the shot is by no means so important a matter as it has been stated, provided the material be a suitable one, and that at close quarters an ordinary smooth-bore gun will answer every purpose.

Being the last experiment that has been tried at the time we write, we will give our readers an account of it, as received from an eminent and experienced eye-witness.

The trial was made in Portsmouth Harbour in the month of January, in the presence of many able scientific men, both civil and military, and the object aimed at was the side of the Target-ship, 'Monarch.' The gun was a plain muzzle-loading, smooth-bore 110-pounder, weighing six tons, and having a diameter of six inches throughout; in dimensions and outward appearance it resembled the old 68-pounder service gun (95 cwt.); it was made at Woolwich, and was called an 'Armstrong.' With a charge of 25 lbs. of powder it projected a spherical shot, weighing about 100 lbs., at 200 yards

* He called it a 70-pounder, but we presume it to be the same.

range, clean through a 4½-inch plate of good iron; and made such havoc in the ship's side, that the aperture was used by the sailors for ingress and egress as a porthole. The great secret, it appears, lay in the shot, which was manufactured by the Messrs. Firth of Sheffield. It was of cast-steel, estimated by our informant to have been worth about 80*l.* per ton; but he added that this would be quite immaterial, for one such shot would produce a more serious effect than a whole broadside from any of her Majesty's vessels. Of this more hereafter. A second experiment was tried with a round shot, made of Bessemer steel. This passed through a plate of 5½ inches thick (same range), but although the ship's timbers were much shattered, the ball did not pass through them, but lodged in them along with some pieces of plate.* With a case-hardened, wrought-iron shot the same effect was obtained against a 4½-inch plate as had been produced upon the 5½-inch plate in the experiment last referred to, showing therefore that the steel shot made at Sheffield deserved the most confidence, *and that that confidence has its money value.*

In fact the whole question appears to be one of pounds, shillings, and pence, and the more we consider it, the better satisfied are we that it is not yet the time to talk about economy; for our experience has still to be purchased, and the sooner we obtain it the better.

"The French frigates," says 'The Times' in a leader, "carry guns of very moderate weight and calibre, but these guns are rifled so as to have a long range, and are supplied with shot of a peculiar material for special use against iron plates. Our own 68-pounders have considerable power at close quarters, but no range; our 110-pounders have long range and great accuracy, but were not found effective against solid plates, except with a particular species of projectile. The actual state of things as regards our naval ordnance may be very briefly described. We have large guns which will send their shot through solid armour-plates, but these are too large for broadside guns, and can only be carried, therefore, in some fashion not yet naturalized in our navy. We have the 68 and 110-pounders above specified, and we have now also manufactured, but not yet issued, a smooth-bore 110-pounder capable of sustaining a charge of 25 lbs. or 30 lbs. of powder, and of piercing a 5½-inch plate. But this new piece, though making fair practice at 2,600 yards, has not the accuracy of a rifled cannon; and what we want therefore, but have not yet got, is a gun which shall combine the accuracy produced by rifling with the power required against solid armour." †

But there are other questions which press themselves upon the attention of those who consider the present transitional state of our armaments. If it be difficult to obtain "broadside" guns, but if, on the other hand, a single shot of a very expensive material may be fired from an ordinary gun, with the damaging effect of a "broadside," will not this last take its departure with the "wooden walls," and give

* This experiment was mentioned by his Grace the Duke of Somerset, but our informant seems to regard it as the less successful of the two, as the ball lodged in the backing. It is necessary to watch these experiments carefully, for here we have not only rival gunmakers, but also rival steel manufacturers.

† We do not know whence 'The Times' derives these particulars, nor what particular gun is referred to.

place to three or four heavy cannons, which will do the work with more effect at a greater range? To this subject a reference was recently made by a correspondent in 'The Times,' and when duly weighed it appears most important. In addition to doing the work more effectively at the least cost in the long run (for, of course, fewer guns will require, proportionately, less men), we have the fact that such a change, by lightening the weight of the equipment, *would admit of the application of a heavier armature*, and there would thus be gained a more powerful means of attack, a more obstinate resisting medium, less expenditure of money, and less waste of life.

For, after all, it is our military engineers who should have these latter objects in view in all their schemes of offence and defence. Although we are not members of the Peace Society, we sympathize with those who are constantly laying stress upon the fact, that war is not only a bloody, but a costly game; a game which will only be played out when the belligerents discover that the stakes, in every case, amount to more than the prizes. Duelling has ceased to be the fashion, because less courage and dexterity are required to put a ball into the body of a man, at 100 yards, than to pierce him through with a rapier; and as war becomes more mechanical, and the cost is increased, whilst the occasions for the display of prowess become less frequent; when man finds that it is no longer a question of the strongest arm, but of the toughest steel—then he will begin to open his eyes to the fact that he is not a fighting, but a reasoning creature; and that if the Almighty had meant to make him resemble a tiger, intending that he should settle his differences by brute force, He would have furnished him with claws, and with a much smaller and less convoluted brain than that of which he now stands possessed.

THE INDUSTRIAL RESOURCES OF THE NORTH COUNTRY.*

It is always of interest to note the onward march of human industry—to see man advancing from point to point, subduing nature, and making each conquest a standing place upon which to apply his knowledge.

Upon this ground, especially, are we pleased with the handsome volume which has been issued under the auspices of some eminent members of the Coal-trade of Newcastle, and of the Institute of Mining Engineers, informing us of the Industrial resources of the Tyne, Wear,

* 'The Industrial Resources of the District of the Three Northern Rivers—the Tyne, Wear, and Tees,' &c. Edited by Sir William Armstrong, J. Lowthian Bell, Esq., J. Taylor, Esq., and Dr. Richardson. Longman, London; Reid, Newcastle.

'A History of the Trade and Manufactures of the Tyne, Wear, and Tees,' &c. Second Edition. Spon, London; Lambert, Newcastle.

'A Handbook to Newcastle-on-Tyne.' By the Rev. J. Collingwood Bruce, LL.D., F.S.A. Longman, London; Reid, Newcastle.

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and Tees. This title, indeed, scarcely expresses the real character of the volume. It is rather an account of the present state of man's industry upon the banks of those rivers, and an indication of resources which are yet to be made available. Three rivers rising amidst the varied scenery of the Mountain-Limestone-hills of Durham, Cumberland, and Northumberland have gathered upon their margins some of the most remarkable evidences of man's power which this country can present to the inquirer; and of these, the several writers, who have contributed to these volumes, have endeavoured to furnish genuine information.

The two works which stand first on our list are almost the same in matter. The first appears as a handsome royal octavo volume, with excellent maps, sections, and plates. The second is very humble in its appearance, and has neither maps nor plates. Both are, however, reprints of the address delivered by Sir William Armstrong, and of certain papers read before the different sections of the British Association, "revised and corrected by the writers." In the first, these papers take the form of special reports; in the second, they are given as isolated papers, and the larger and illustrated volume adds important "Reports on the Improvements introduced in the Rivers of the District."

The little volume which stands last on our list, is one of the most complete "Handbooks" which has ever fallen into our hands. Its archæological and descriptive division being the work of a man eminent in that department of knowledge, while the portion devoted to the manufactures of Newcastle has been produced by the mayor of that town, who, by his vocation and special knowledge, is peculiarly fitted for the task.

With this notice of the general character of these books we leave them, except in as far as they aid in obtaining a correct knowledge of the present state and of the prospects of those industries which come under notice.

The present annual produce of coal from the Great Northern coal-field is given by the reporters at 21,777,570 tons. This is somewhat in excess of the quantity given in the "Mineral Statistics of the United Kingdom." The vend of coals both Coastwise and Foreign, was, in 1791, 2,079,605, which advanced in 1862 to 10,134,790 tons; the remainder having been consumed in the manufactures, railways, and mines, and for domestic purposes at home.

With this great drain upon a limited area, the question raised by Sir William Armstrong, of the duration of the supply, becomes a most important one. In our last number, however, we gave this subject sufficient attention. The engineering of coal-mining is clearly treated of. Boring, coal-cutting, coal-washing, ventilation, and lighting coming under notice. The coal-cutting machine of Donesthorpe and Co. is especially noticed; and the reporters say:—"We shall thus be enabled to work profitably seams of coal varying from one foot six inches, to two feet in height, or even lower, and thus vastly prolong the duration of the coal-field." This view was not embraced in our notice of the coal-cutting machines in our last number.

We could have desired a more extended notice of Coke manufacture than that which has been given.

The paper on Iron, by Mr. J. Lowthian Bell, is a most important one, and to the date of its production it may be said to have exhausted the subject, forming, as it were, the balanced ledger of the ironmaster. From this paper we learn the production of Pig Iron, for three years, to have been:—

	1860. Tons.	1861. Tons.	1862. Tons.
Northumberland	69,093	73,260	46,586
Durham	340,921	312,050	337,218
Yorkshire—North Riding . . .	248,665	234,656	283,398
	658,679	629,945	667,202

There were 646 puddling furnaces in action. "The united power of all these works will be equal to an annual production of 340,000 tons, and probably the actual make during the year 1862 may have amounted to 300,000 tons." The manufacture of steel is treated of in a very brief paper by Mr. Spencer.

The local manufactures of lead, copper, zinc, antimony, &c., have been treated of by Mr. Sopwith and Dr. Richardson. Mr. Sopwith has naturally dealt with the lead mines of the district, and given a concise account of Alston Moor, Weardale, and Teesdale. In 1862 the Cumberland division gave 5,241 tons of lead, and 41,911 ounces of silver; Durham and Northumberland giving 16,454 tons of lead, and 82,854 ounces of silver.

The copper ore raised in those counties is very small, but some copper is obtained from the sulphur ores (Iron Pyrites) which are employed in the manufacture of sulphuric acid. Zinc is obtained in small quantity. The ores of antimony are all imported. In addition to these papers, Mr. J. Lowthian Bell has given a notice of the manufacture of aluminium, this paper concluding the series devoted to the production of the metals.

The Chemical manufactures of the district have been described by Dr. Richardson, Mr. J. C. Stevenson, and Mr. R. Calvert Clapham. The total value of the products of these industries is stated to be 145,520*l.* sterling.

As an Appendix to this, we have a note on the recent discovery of Salt at Middlesbro'. Messrs. Bolckow and Vaughan being anxious to obtain a supply of fresh water for their iron works, commenced, about four years ago, to sink a shaft for this purpose. This well did not answer their expectations, and a very large bore-hole was put down from the bottom of the shaft. The strata passed through are in the upper New Red Sandstone, or the same in which the Cheshire rock-salt is found. In August, the depth attained was 217 fathoms—the last 100 feet being through a bed of salt—at the bottom of which they had not at that time arrived. It is impossible to overrate the importance of such a discovery to this district, where the consumption exceeds 100,000 tons per annum.

Clay wares and glass are manufactures which have been long esta-

blished on the Tyne. They are succinctly described, and the annual value stated to be as follows :—

	£
Glass	638,000
Earthenware	190,000
Fire-clay Goods	228,650
	£1,066,650

The manufactures of Paper and Leather are briefly reported on; but more important are the papers on "The Construction of Iron Ships," by Charles H. Palmer; and on "The Engineering Manufactures," by P. Westmacott, C.E., and J. F. Spencer.

Valuable Appendices introduce us to Sir W. Armstrong, who clearly describes the construction of Wrought-iron Rifled Field-guns; and to Mr. John F. Tone, C.E., who takes charge of "Railways and Locomotives."

The improvements now being carried out on the rivers Tyne and Tees are described by Messrs. Ure and Fowler with much precision.

From this notice of these volumes, it will be seen that a large amount of energy is expended upon the natural advantages of this important Northern Coal-field, from which we may expect yet more gigantic results. Sir William Armstrong well says—"The tendency of progress is to quicken progress, because every acquisition in science is so much vantage ground for fresh attainment. We may expect, therefore, to increase our speed as we struggle forward; but, however high we climb in pursuit of knowledge, we shall still see lights above us, and the more extended our view, the more conscious we shall be of the immensity which lies beyond."

QUALITATIVE CHEMICAL ANALYSIS.*

THIS book has been long and favourably known to the British public. It is *par excellence* the standard work upon the subject of which it treats: the system of instruction is that which first met with general adoption in this country by the student in analysis, and the successive improvements in chemical methods and research have from time to time been duly chronicled: so that in the edition just now published we have at once a full and satisfactory account of all that is known on the subject. By the insertion of a large amount of new matter the dimensions of the volume have been greatly augmented, the present edition having been expanded to 350 pages, and in comparing this with former editions it is manifest that the introduction of the new system of spectrum analysis has added much to the impor-

* 'A System of Instruction in Qualitative Chemical Analysis. By Dr. C. Remigius Fresenius. Edited by J. Lloyd Bullock, F.C.S.' Sixth Edition, 1864. London: John Churchill and Sons, New Burlington Street.

tance of the work. A noteworthy addition is the beautifully coloured frontispiece illustrative of the more characteristic spectra among the metallic elements. It is much to be regretted that the position of the single green ray of thallium is not indicated in the spectrum chart; but, as though to compensate in some measure for this omission, a remarkably good account of the new metal and its principal reactions will be found in the chapter on thallium. The most approved forms of spectrum apparatus, particularly those devised by MM. Kirchhoff and Bunsen, are here fully described and illustrated by woodcuts. The chapter on apparatus generally has received important additions; we may mention especially the very useful instrument recently invented by Professor Graham, and known by name as the 'Dialyser.' The application of this instrument in the detection of poisons, and the important aid it is likely to render in toxicological examinations by affording a simple means of extracting the poisonous principles from the host of heterogenous organic matters with which they are commonly associated, are treated of at length and in a manner suitable to the growing importance of the subject. Special instructions are laid down for the recognition of the vegeto-alkaloids,—a class of bodies which are becoming daily of more extended use as remedial agents and therefore of more frequent occurrence as objects of chemical study,—and a chapter is devoted to a systematic course to be followed in the detection of unoxidized phosphorus, hydrocyanic acid, arsenic, strychnine, &c. In short, as a treatise on toxicology, 'Fresenius' Analysis' can be confidently recommended: and in this connection the numerous illustrations of apparatus employed in the detection of these poisons cannot fail to be highly suggestive to the analyst engaged in medico-legal inquiries.

The leading characters of the rarer metals, *e.g.* cæsium, rubidium, thorium, cerium, lanthanum, didymium, and even erbium and terbium, are pointed out under their respective analytical groups, and these particulars are printed in small type to denote their minor importance. In consequence of the foreign origin of this work there are one or two trifling instances of departure from the ordinary nomenclature to be observed, thus, the earth glucina is described as "berylla," and the metal tungsten has received the appellation "Wolframium." The chemical symbols Be and W partly sanction the employment of these names, but by the same rule, the common potash and soda would become *kalia* and *natria*.

The system of analysis adopted throughout is that which has received the sanction of the highest authorities both in this country and abroad; the methods of separation are extended occasionally by the necessity for giving the several approved modes for effecting the object, where the attainment of absolute success is a matter of some difficulty, and even now we are disposed to question the accuracy of the processes recommended for the separation of antimony, tin, and arsenic.

In the body of the work are given full directions for the analytical examination of plant-ashes, agricultural soils, and mineral waters; much of the information upon these points remains substantially identical with

former editions. We notice particularly that the organic constituents of drinking waters continue to be described under the indefinite titles of "crenic and apocrenic acids." The use of these terms cannot be considered satisfactory at a time when they are never employed in chemical reports. It must be admitted, however, that the identification of dissolved organic matters, and the determination of their amount by quantitative analysis, are still far from satisfactory, and constitute subjects urgently requiring further chemical research. Again, in the preparation of vegetable ashes for the purpose of identifying and determining the mineral constituents of the plant it would be good policy to abstain in all cases from applying such a degree of heat as will be required from the complete incineration of the organic structure, inasmuch as the employment of so elevated a temperature is sure to induce the loss by volatilization of a certain proportion of the alkaline salts. A more judicious course consists in using no greater heat than is required for the complete charring of the organic matter, then to extract with water in order to remove the soluble salts, and afterwards dry and burn the carbonaceous residue for the purpose of recovering the remainder of the mineral salts.

The work is remarkably well printed, and free from errata. The mode of division into chapters and paragraphs, distinctly numbered, facilitates reference; and there is much satisfaction in being informed of the authority upon which a statement is made, and the name has been generally given between parentheses. A very useful table of weights and measures concludes the volume. There are some repetitions to be noticed in the analytical details prescribed for the examination of simple and of complex substances; but these are only such as could not be entirely avoided in a work devoted to instruction. Altogether, we feel strongly disposed to recommend this treatise to the favourable notice of the student in chemical analysis; and must remark, in conclusion, that the sixth edition fully maintains the high character of a standard work which "Fresenius' Analysis" has so long enjoyed.

PAMPHLETS.

THE POWER OF GOD IN HIS ANIMAL CREATION. By Professor R. Owen, D.C.L., F.R.S. Nisbet.*

IT is not always the iconoclast who renders the greatest services to his fellow-men. Much as we may admire the courage of the man who steps forth boldly from the crowd, and under the conviction that the idol which it adores must be broken in order to show its impotence, shatters it to fragments; we have still more faith in him who quietly leads the terrified worshippers up to the stone image, and seeking to soothe their apprehensions, satisfies them by the touch that it possesses no life, nor yet the power to injure or befriend them. Errors inculcated during long ages may be shaken for an instant, but they cannot be eradicated by a *coup d'état*, and it often happens that a gentle and well-timed remonstrance has a more lasting influence upon the minds of men than the loudest, though they may be the most rightful denunciations.

We have before us an illustration of this fact in the delivery of the present lecture to the Young Men's Christian Association, in which Professor Owen has not only rendered an important service to science, but has displayed great moral courage in planting the banner of progress and free discussion upon the walls of a fortress that few younger men would have ventured to storm. In direct opposition to the preconceived views entertained by the large majority of his hearers on theological subjects, he stated firmly, but temperately, the results of modern scientific research, most widely at variance with the tenets of many orthodox theologians, and gave additional force to his uncompromising assertions, by selecting only those topics which are no longer open to debate.

The vast assemblage of his hearers, lay and clerical, men and women of every age and temper, would be nearly unanimous in the belief that the world is about 6,000 years old, and that the whole fabric, with its living denizens, was formed perfect in seven days of twenty-four hours; but he told them that the researches of science have led to the certainty that such a period is utterly, "nay, absurdly inadequate," for the Divine operations as they are conducted, to have prepared and peopled the dry land.

He assured them further, that instead of physical death having come into the world with the "fall," "life has been enjoyed during the same countless thousand of years; and that with life, from its beginning, has been death." And by means of a diagram, showing the geological and palæontological history of the past, with the traces of man, osseous and archæological (if we may so call them), he exhibited to them the indisputable evidence of his great antiquity.

And should even the Darwinian theory of the natural selection of new

* A Lecture delivered in Exeter Hall before the Young Men's Christian Association.

species through secondary agencies ever come to be an acknowledged law, Professer Owen will have done much to prepare these young men for its reception, for after showing them that the Creator has brought all his works to perfection by a gradual development, he told them that "just as death is met by birth, so extinction has been balanced by creation, that is, a constant and continuous operation of Creative Power, which has produced a succession of species;" also, that "we discern no evidence of pause or intermission in the creation or coming to be of new species of plants and animals." And lest there should be any mistake as to his meaning, he repeats his belief in "the world's vast age, and in the unintermittence of creative acts," notwithstanding that such views may be regarded by some of his hearers with "abhorrence." Professor Owen hoped, however, that there were no such prejudiced persons in his auditory.

Nor did he confine his admonitions to his lay hearers. He spoke to the clerical portion of his audience of the futility of attempting, to put a literal interpretation upon symbolic texts in Scripture, as though they were statements of matter-of-fact. His illustration he drew from the supposed erect attitude of the serpent before the temptation of Eve, explaining that, instead of being the "progeny of a transmitted species, degraded from its original form as the penal consequence of its instrumentality in the temptation of Eve," the structure and organization of these animals are specially adapted to their position and habits, being replete with "instances of design in relation to the needs of their apodal vermiform character." And he reminded his clerical friends of the opposition interposed in the way of progress by the priesthood of old, repeating the admonition of St. Augustine, that men *will* believe the earth to be rotund, and should they preach it to be flat and denounce the new doctrine, they will say, "If ye know so little of earthly things, how shall we believe you when you tell us of heavenly ones?"

There need be no apprehensions for Christianity under the new regime, he said, inasmuch as it has suffered nothing since physical doctrines "declared contrary to Holy Writ" have been established; and he concluded his address as follows:—"Allay, then, your fears and trust in the Author of all truth, who has decreed that it shall never perish; who has given to man a power to acquire that most precious of his possessions with an intellectual nature that will ultimately rest upon due demonstrative evidence."

Some may think that the lecture is marred by the too frequent introduction of Scripture texts and quotations; but, on the whole, it is a noble address, and the Committee of the Young Men's Christian Association have studied their own interests in giving it a large and unrestricted circulation.

THE NEGRO'S PLACE IN NATURE. By James Hunt, Ph.D., &c. Trübner and Co.

IN the Introduction to this 'Journal' we referred to a paper on the above subject, read before the members of the British Association; and this is now published, the author tells us, by the general wish of the Fellows of the Anthropological Society, of which he is the president.

We ventured, in speaking of the original paper, to differ from the views of the author, which we believe to be contrary to the evidence and at variance with the opinions of the most advanced physiologists of the day, and drew attention to the fact that the most important question of hybridity had been almost completely ignored, and that what little was said of it ran counter to the author's doctrine of a specific difference between the white man and the Negro. We also mentioned, in passing, that a Newcastle journal did not hesitate to hint broadly that the gentlemen who thus sought to degrade the Negro race (for the president found a warm supporter in his secretary, Mr. Carter Blake) were the tools of the Southern confederacy, and that their services had been enlisted as the champions of slavery in England.

In adopting the supposition of the Newcastle paper, we confess that we were guilty of indiscretion, and we have to apologize to the shrewd and discerning politicians who administer the affairs of the Southern Confederacy, for having supposed them capable of adding to the indiscretion of attempting to found their new empire upon the basis of slavery, by using such an instrument as this for the purpose of obtaining sympathy in England.

No! Great as may be the fatuity of the Southern people on the question of slavery, they would never have attempted thus to "inoculate" us, the "outer barbarians," as the author has it in his dedication to "My dear Burton;" and we are now prepared to accept his statement concerning the object of his paper, as perfectly original and emanating from himself alone,—*viz.* that when the truth comes out, "the public will have their eyes opened, and will see in its true dimensions that gigantic imposture known by the name of 'Negro Emancipation.'"

But we must treat our readers with an extract from the work, in order that they may judge of the kind of material with which it is intended to explode this "gigantic imposture," and they will at once have an opportunity of judging of its science and its *morale*:—

"But while the analysis of a single bone or of a single feature of the Negro is thus sufficient to demonstrate the specific character, or to show the diversity of race, that great fact is still more obviously and with equal certainty revealed in the form, attitude, and other external qualities. *The Negro is incapable of an erect or direct perpendicular posture.* The general structure of his limbs, the form of the pelvis, the spine, the way the head is set on the shoulders, in short, the *tout ensemble* of the anatomical formation forbids an erect position. But while the whole structure is thus adapted to a slightly stooping posture, the head would seem to be the

most important agency; for with any other head, or the head of any other race, it would be impossible to retain an upright position at all. But with the broad forehead and small cerebellum of the white man, it is perfectly obvious that the Negro would no longer possess a centre of gravity; and therefore, those philanthropic people who would 'educate' him into intellectual equality, or change the mental organism of the Negro, *would simply render him incapable of standing on his feet, or of an upright position on any terms.*"*

We presume it will not be necessary for us to refute the assertions (adopted by the author as evidence of the specific difference between the Negro and the white man), that the Negro is "*incapable* of an erect or perpendicular position," and that education would "*render him* incapable of standing on his feet, *or of an upright position*"!

The kings of Western Equatorial Africa, we are told, are under the necessity of encouraging the slave trade, in order to get rid of their criminals.

"No one, we presume, will dare assert that there are no criminals in Africa! What shall we do with our criminals? may be a problem which is occupying the attention of the political economist of Africa—like His Majesty the King of Dahomey—as well as the government of Great Britain. Is Africa not to be allowed to export her criminals, or are they so worthless and unmanageable that no people will have them?"

But it must not be supposed that the author advocates the slave-trade. Oh dear, no! He "protests against being put forward to advocate such views." "Our Bristol and Liverpool merchants," he says, "perhaps, helped to benefit the race when they transplanted some of them to America, and our mistaken Legislature *has* done the Negro *race*"—(why not species?—merely the force of habit, we presume)—"much injury by *their*† absurd and unwarrantable attempts to prevent Africa from *exporting* her worthless or surplus population." We have done; and if, after these extracts, our readers feel any desire to know more of the work, they must purchase it; for, although it is a tract such as we are ashamed to see printed in the English language, it has found a respectable publisher.

The Batavian Society of Experimental Philosophy in Rotterdam ‡

We desire to draw the attention of our leading Literary and Philosophical Societies to the plan adopted by the body of savants to whose prospectus we are about to refer, for encouraging the study of practical science, and would recommend it to their consideration whether a similar method of awarding premiums for careful research would not add much to their usefulness and success.

* The author is here quoting a Dr. Van Evrie of New York. The italics are ours.

† We again claim the italics; the grammar is the author's.

‡ The Society's 'Programme,' issued in December, 1863. Imprimerie de G. and C. A. Van Reyn, Rotterdam.

It is indeed seldom that we have read the programme of any institution with so much gratification as this one; it is as concise as it is interesting, and the only objection we have to the Society is its name, for it would convey a better idea of its operations if it called itself a practical, instead of an "experimental," institution.

The Council awards three prizes annually: a gold and silver medal, and a premium varying in amount from 50 to 150 florins,—a total therefore of 30*l.* or 40*l.*, which would be no serious outlay for any of our leading metropolitan or provincial scientific institutions.

As to the questions propounded, we shall convey the best idea of their character, and at the same time give the most practical effect to our suggestion, by translating and inserting a few of them in these pages.

Question 106. (Evidently intended for sailors.)—"The Society believing that an investigation of the temperature of the water in extensive seas, and at considerable depths, would be of great importance for ascertaining the physical state of our globe; and feeling satisfied that on board many vessels this temperature may under favourable circumstances be determined; desire to receive accurate researches on the subject, undertaken (with the employment of proper nautical instruments for ascertaining the latitude and longitude) in places where such experiments have not yet been made. The results must be stated succinctly, and in a careful detailed manner."

Question 114.—"For many years past scientific men have debated the possibility of constructing, on the seaboard, harbours of refuge for vessels with a deep draught of water, similar to those found on the northern and southern coasts of Holland. It has been asserted that, with the progress made in science, the construction of such harbours no longer offers any difficulties."

The Society therefore requires the complete plan of a harbour upon a coast such as, for example, Schevening, which would admit, at low tide, vessels drawing 23 feet of water" (7 metres), "and having an entrance wide enough to allow such vessels to cast anchor inside, with a violent gale blowing from the NE. The cost of construction and annual maintenance is also required."

Question 135.—"It is important that persons engaged in the study of electricity should make themselves acquainted with the phenomena produced upon telegraph wires by storms and by the Aurora borealis. Many of these phenomena are very partially understood, and it is desirable that more extended experiments should be communicated, from which it would be possible to make deductions."

Question 137.—"Mr. Tyndall believes his experiments have proved beyond a doubt that the vapour of water" (a moist atmosphere) "exercises a more powerful absorbent influence upon radiant heat than dry atmospheric air. Mr. Magnus, on the other hand, considers himself justified in concluding from *his* experiments that there is no difference in the absorbent property of a dry and of a humid atmosphere. The Society would wish to see these conflicting views met by conclusive experiments."

Our limited space will not admit of the insertion of more of these

questions, but we may state that they are all of more or less general interest, and that the large majority are practically useful. Some deal with local improvements; others, with the statistics of the country; and others. again, require investigations in the various branches of Physical and Mechanical Science, in Crystallography, Geology, Chemistry, Botany, Physiology, &c.

The replies of competitors, which are expected to take the form of short essays, may be indited in the Dutch, French, English, German, or Latin languages, and as far as we are enabled to judge from the precautions taken to ensure impartiality to all candidates, and secrecy to unsuccessful ones, we should say that students are justified in placing their labours in the hands of the Society in perfect confidence that they will receive fair treatment.

As we have already observed, we hope that some move will be made in this practical direction amongst our English Institutions; the Society of Arts already awards such prizes, but there is no reason why every important "Philosophical" Society should not do the same, and we shall be glad to receive more of these programmes from other countries, in order to extract from them any new features in their management, for the benefit of our English readers.

Spectrum Analysis.

Those of our readers who may be able to read the Dutch language, will find in it one of the best works yet published on Spectrum Analysis.* The book is so good that it deserves translation into a language that would ensure it a wider circulation; and as we are in want of such a work in England, we commend it to the notice of any good Dutch scholar and chemist. Tracing the art from its first origin, the author brings down his account of the successive discoveries to the latest published observations of Bunsen, Kirchoff, and Miller, describing most of the observed spectra, and giving what will be found extremely useful to many—a very complete bibliography of the subject. The work is accompanied by some beautifully-executed coloured drawings of various spectra.

One of the earliest applications of the prism to chemical analysis was that of Plucker, who observed the lines produced by the passage of electricity through a rarefied gas, and noticed that in every gas, when pure, a particular system of lines was obtained. The minute portion of a gas, whether simple or compound, that could be analysed in this way induced the author to style the method *microchemistry*. It was really spectrum-analysis. M. Morren followed up the researches of Plucker, and now publishes at Marseilles a tract,† the object of which, he says, is to point out how this mode of analysis may help to solve

* De Spectraal-Analyse &c.'—On Spectrum Analysis, &c. By H. C. Dibbits. Rotterdam: E. H. Tassemeijer. 1863.

† 'Des Phénomènes Lumineux que présentent quelques Flammes, et en particulier celle du Cyanogène, et de l'Acetylène, &c.' Par M. Morren. Marseilles: Arnaud & Co., 1863.

questions which ordinary chemical processes are unable to unriddle. What, for example, constitutes the blue part of the flame of a candle? The spectroscope answers, vapour of carbon. The author once thought that the blue was caused by light carburetted-hydrogen, since he observed the same spectrum from the flame of this gas, and also from that of the base of a candle flame. A perusal of Dr. Attfield's paper on the "Spectrum of Carbon," however, induced him to reconsider the subject, and to examine the spectra of numerous other carbon compounds. In all these he observed the same spectrum, which, being common to everyone, must have been derived from the common constituent, carbon. The means which the author employed, and the appearances he observed, are well described in this tract; and any experimenters working in the same direction would do well to consult it.

Chemical Formulæ.

Dr. Odling has published* a set of tables of chemical formulæ, which we venture to say will prove as useful to teachers as to students of chemistry. He adopts an original mode of classifying the elements which is, perhaps, as reasonable as any other yet proposed, or possible, in the present state of our knowledge of these bodies.

The formulæ are all constructed on the unitary system of notation, and in the absence of a complete work of chemistry based on that system, these tables will prove of great assistance to students, who are obliged to read a book written upon the old system, and listen to a lecturer who teaches upon the new.

Lecturers who are beginning to teach the unitary system, will find in the tables the materials of a very useful set of diagrams.

* 'Tables of Chemical Formulæ,' arranged by W. Odling, M.B., F.R.S, &c., &c. London: Taylor and Francis, 1864.

NOTES AND CORRESPONDENCE.

Silvered Glass Telescopes and Celestial Photography in America.

By Professor Henry Draper, M.D., New York University.

New York, *Feb.* 2, 1864.

The first photographs of the moon were taken in 1840 by my father, Professor John W. Draper, M.D., who published notices of them in his quarto work, 'On the Forces that Organize Plants,' and in the 'Philosophical Magazine.' The specimens were about an inch in diameter, and were presented to the Lyceum of Natural History of New York. They were made by means of a lens of five inches aperture, furnished with an eye-piece to increase the magnifying power, and mounted on a polar axis driven by a clock. At that time it was generally supposed that the moon's light contained no actinic rays, and was entirely without effect on the sensitive silver compounds used in daguerreotyping.

In 1850, Mr. Bond made use of the Cambridge (Massachusetts) refractor of 15 inches' aperture, to produce daguerreotype impressions of our satellite, the sensitive plate being placed at the focus of the object-glass, without the intervention of an eyepiece. Pictures two inches in diameter were thus produced, and, subsequently, some of the same size were made on glass, and mounted stereoscopically. Mr. Bond also made a series of experiments to determine whether photography could be advantageously applied to the measurement of double stars, and concluded that the results were as reliable as those derived from the micrometer.*

Soon after, Mr. Warren De La Rue, of Cranford, near London, undertook by the aid of a 13-inch speculum, ground and polished by himself, to procure a series of photographs of the moon and other celestial objects. The excellent results that he has obtained, together with those of Professor Phillips, Mr. Hartnup, Mr. Crookes, Father Secchi, and other physicists, are doubtless familiar to all scientific men, having been published in the form of a report to the British Association in 1859. No detailed description of them is necessary, therefore, in this place.

In 1857 Mr. Lewis M. Rutherfurd, of New York, erected an equatorial refractor of 11 inches' aperture, the object-glass of which he had himself corrected, and has taken a large number of lunar photographs with it. They have generally borne to be magnified to five inches, and he is now engaged in perfecting a correcting lens that will allow still greater enlargement to be used.

The moon, as seen by the naked eye, is about one-tenth of an inch in diameter, although persons generally estimate it at 10 inches. That the first statement is true is easily proved either by taking a photograph with a lens of 10 inches' focal length, or more convincingly by holding up between the moon and the eye a little disc one-tenth of an inch across, at the nearest distance of distinct vision (10 inches). A picture of the moon of the size commonly attributed to her requires to be made under a power of 100 times.

In 1857 I visited Lord Rosse's great reflecting telescopes at Parsonstown, and had an opportunity of not only seeing the grinding and polishing operation by which they were produced, but also of observing some stars through the six-foot instrument. On returning home in 1858 it was determined to construct a large instrument by similar means, and devote it especially to celestial photography. The speculum was of

* 'Astron. Nach,' No. 1129.

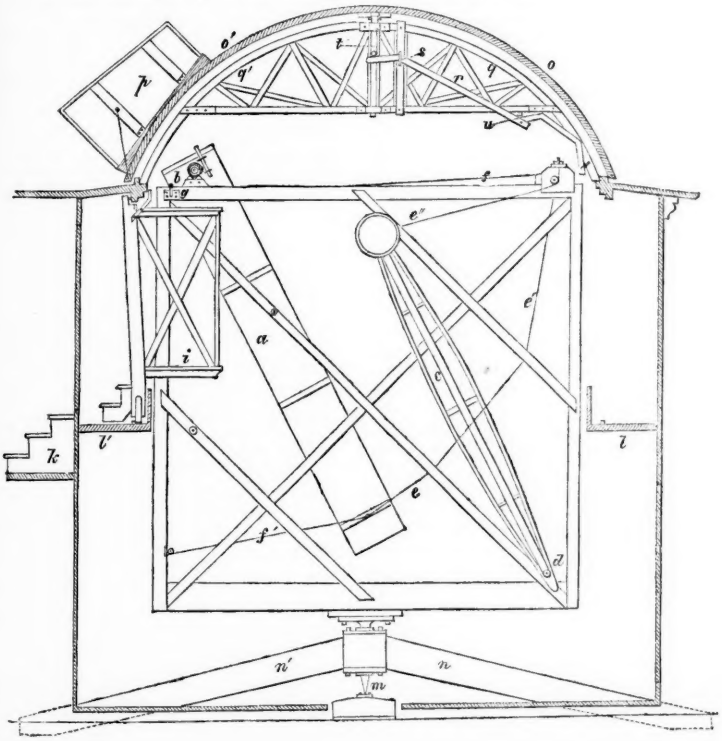
15 inches' aperture, and 12 feet focal length. Subsequently, however, this metal mirror was abandoned, and silvered glass, as suggested by M. Foucault, substituted. This latter, according to Steinheil's experiments, reflects more than 90 per cent. of the light falling upon it, while speculum metal only returns 63 per cent. A detailed account of this instrument, amply illustrated, is now being published by the Smithsonian Institution at Washington, and therefore only a general idea of its peculiarities will be given.

As the telescope was intended especially for photography, the following general principles were adopted. 1st. A reflector was, of course, preferred to an achromatic object-glass, because all the rays falling upon it are reflected to the same focal plane, and there is not, as in the latter, one focus for distinct vision, and another for the photographically actinic rays, an inch distant perhaps. In the reflector a sensitive plate put where the image is seen to be most sharply defined, will be sure to give a good result. In the achromatic, on the contrary, the sensitive plate must be placed in a position which can only be found by tedious trials. 2nd. Silvered glass was used instead of speculum metal, because it is lighter and more highly reflecting. Besides, if a reddish or yellowish film should accumulate on it—an accident liable to occur to either kind of reflector and seriously diminishing the photographic power—it can either be repolished with a piece of buckskin—an operation obviously impossible in the case of a speculum metal—or the silver can be dissolved off with nitric acid, and a new film deposited on the glass concave. The glass which has been made accurately parabolic before the first silvering, is not changed in figure, the silver being only deposited in a layer $\frac{1}{200000}$ of an inch thick, and consequently, if carefully prepared, copying the glass below so closely that no error larger than a small fraction of that amount is possible. As the glass only serves as a basis or mould for the thin sheet of silver, and is not penetrated by the light, its quality is a matter of but little moment, that which is used for skylights or light-openings in floors answering perfectly. 3rd. A mounting, presenting the greatest degree of steadiness possible was necessary. For this purpose the telescope was supported at both ends, the lower one resting in a loop of wire rope. 4th. Instead of driving the whole mass of the instrument by clockwork acting upon a polar axis, and thus being forced to move a weight of at least half-a-ton—the usual system in equatorials — only the sensitive plate and its frame, weighing an ounce, were caused to follow the moon or other object, the mass of the apparatus remaining perfectly at rest. This idea is due to Lord Rosse. 5th. Instead of using a clock with wheelwork for a prime mover, a *clepsydra* was substituted. This consists of a heavy weight supported by the rod of a piston, which fits into a cylinder filled with water. At the bottom of the cylinder a stopcock permits the water to flow out at a variable speed, depending on the amount of opening. The sensitive plate can thus easily be caused to coincide in rate with the moving object, and yet by a motion free from irregularity and tremor.

The value of a silver reflector turns, of course, entirely upon the perfection of the glass concave on which the metallic film is to be deposited. This must be of a parabolic figure, so that spherical aberration may be completely corrected. A person is, however, content to take the utmost pains to produce it, because, once attained, the figure cannot be lost except by fracture, and the value does not diminish with time as in the case of a speculum. It never requires re-polishing. The best method of grinding and polishing the glass is by means of an apparatus that I have called a "Local-correcting Machine," by which all the parts of the surface can be attacked in succession and reduced to the desired curvature,

and yet at the same time a uniform curve and absence of local irregularities secured. I have spent five years in the investigation of this subject, and have polished more than 100 mirrors of from 19 inches to one-fourth of an inch in diameter, on seven different machines built at various times. The quality of those I have at present is indicated by the fact that they will show *Debillisima* to be quintuple, and will render the close companion of Sirius, discovered by Alvan Clark's magnificent 18½-inch refractor, visible.

The Observatory at Hastings-upon-Hudson, near New York, lat. 40° 59′ 25″ N., long. 73° 52′ 25″ W. of Greenwich, is upon the summit of a hill 225 feet above low-water mark. It is 20 feet square, with a wing 9 × 10 for a photographic laboratory. As the telescope is a Newtonian, with the mounting so contrived as to have the eyepiece stationary at all altitudes, a plan originally suggested by Miss Herschel, there are peculiar facilities offered for easy access to the eyepiece, or place of the sensitive plate. The interior height of the Observatory, 22 feet, is divided into two stories, around the upper of which an observer's chair runs to follow the telescope. The dome turns upon a pivot at its centre, instead of on rollers or cannon-balls around the edge, and is moved consequently with but slight exertion.



In the woodcut *a* is the telescope tube, *b* one of the trunnions on friction rollers perforated for the eye-piece, *c* one of the counterpoise levers, having a weight at the upper end and being attached to an axle *d* at the lower end; *e e' e''* is a wire-rope going from the counterpoise to the lower end of the telescope; *f f* another wire-rope which passes round a small drum connected with the winch *g*, and gives the observer standing on the observer's platform *i* the power of moving the telescope in altitude; *k* the stairs going to the photographic room, *l l'* the gallery that divides the Observatory into two stories, *m* the azimuth axis resting on the solid rock, and sustained at its upper end by the three lateral beams, *n n'* (two only are shown). They also rest in cavities in the rock. The dome is seen in section at *o o'*, the dome-opening and shutter at *p*, the dome-arch at *q q'*. The dome-raising lever *r*, with the fulcrum at *s*, is shown as it appears when the dome is prepared for revolving, the axis *t* carrying the whole weight. The part of the lever below the detent *u* can be bent up out of the way, and held by a loop.

Since the telescope has been completed, and furnished with two parabolic mirrors of 15¾ inches aperture, and 150 inches focal length, and one Herschelian mirror (that is, a concave of such figure that it can only bring oblique pencils to a focus free from aberration), Celestial Photography has been continually prosecuted. About 1,500 lunar negatives have been taken. Old experience obtained from portrait and microscopic photography has proved to be of great service. At first the well-known processes were used, but it was soon found that something more refined was needed, where the pictures are to be submitted to magnifying powers of perhaps 25 times. Defects in collodion negatives that would, under ordinary circumstances, pass unnoticed, assume such prominence as greatly to diminish the beauty of the results. These defects, pin-holes, coarse granular appearance of the reduced silver, and other markings, were found to arise principally from the presence of nitrate of silver on the sensitive plate. It was ascertained that by washing the plate thoroughly before exposure they disappeared, or were very much ameliorated, and without any reduction in sensitiveness. But for this washing operation pure water is needed, and hence the roof of the buildings was painted with a ground mineral compound that hardens to a stony consistence, and the water falling upon it was preserved in a leaden tank, which from long use for other purposes had become thickly coated with insoluble salts of lead, sulphates, &c. Whenever an inch of rain falls, a ton of water is collected, and the tank may be filled about 32 times in a year.

The negatives produced at the focus of the reflector are on an average $1\frac{4}{10}$ inches in diameter. Many that have been made will bear to be enlarged to 2 feet, and one was taken September 3, 1863, at 4.30 A.M., which has been increased to 3 feet in diameter, the total magnifying power used being about 380. In this photograph the moon may be said to be shown on a scale of 60 miles to the inch.

In the process of enlarging I have introduced one very important novelty. Instead of employing an achromatic combination of lenses arranged as a solar camera, a *concave mirror* is used. It entirely gets rid of the difficulty of chromatic aberration, which is, as all photographers know, one of the most serious obstacles to success, and, in addition, the magnified image lies in one plane, or there is what is termed a *flat field*. Every little detail of the original negative is perfectly reproduced, and a 3-foot image is as sharp in one part as in another. The effect of portraits reproduced of life-size is very striking, and the resemblance to the individual singularly increased. In magnifying these lunar negatives, a

mirror of 8 inches' aperture and 11½ inches' focal length is used. At first, when it was intended to employ diffused daylight and the whole aperture, the figure was made elliptical, with a distance of 8 feet between the conjugate foci; but subsequently, when the advantages of sunlight were understood, the surface was reduced by a diaphragm to 1½ inches in diameter, and a part of the mirror as nearly perfect as a mirror can be made at present was selected. Success in enlargement becomes with this contrivance a certainty.

The "enlarger" is also equally valuable in copying by contact. When a small negative is enlarged and photographed, what is termed a positive results. If such a positive is used to make prints on paper, the lights and shades are inverted, and that which is white is shown black. It is necessary then to turn the original negative into a positive, so that when magnified a negative may result suitable for printing positive proofs on paper. This is done usually by a process called reversing, in which a sensitive plate is placed behind the original negative, and the two exposed to the light. Wherever the negative is transparent the plate behind is stained by the light, and where opaque, it is protected. But unless the plate behind is so close as to make the chances of scratching the negative very great, the positive produced is much inferior in distinctness, because the diffused light of day finds its way through in many directions. If, however, the negative and sensitive plate are placed in the beam of sunlight coming from the enlarger, the rays pass through only in one direction, and the reverse or positive is as sharp as the original negative.

Celestial photography is as yet only in its infancy. The results to which it has given origin, although excellent in many respects, have imperfections. But it seems probable that these may be overcome in the future, partly by means now within reach, and partly by others which may be discovered at any moment. In looking at a 3-foot photograph from such a distance that the eye can embrace it all at one glance, the general effect is certainly very fine, and superior to observation through the telescope with a similar power. The moon appears as it would if viewed from a stand-point 600 miles from its surface. Ranges of mountains, as the *Apennines*, seem as if projected out from the general level, while the great craters, such as *Plato*, *Theophilus*, and *Clavius*, are deeply excavated below. Grooves of vast extent, like those diverging from *Tycho*, and faults such as that running past *Kant* and *Catharina* on the one side, and *Tacitus* on the other towards *Lindenau*, still further break up the surface. The well-known seas and bright portions, so distinct to the naked eye, are lost in the multiplicity of the details into which they are resolved.

But coming more closely to the picture, and examining with a critical eye, it is apparent that, although the general effect is the same as would be perceived by looking at the moon itself, yet some of the minute details seen in the telescope with a high power are absent.

The reasons which lie at the bottom of this difficulty are connected to a certain degree with the photographic processes employed, but also to not a little extent with the condition of the air. The quality of the instrumental means used is, of course, of primary importance. A good photograph cannot be taken with an inferior telescope and clock.

The obstacles arising from photography result from the fact that the dark parts of the picture are not formed by a continuous sheet of material, but by an aggregation of granules which, though invisible to the unassisted eye, are seen when a high-enough magnifying power is employed. Their degree of visibility turns on the system of development used for bringing out the latent image on the sensitive plate. A picture injudiciously forced with

pyrogallic acid will hardly bear any enlargement, though one made with sulphate of iron and a well-regulated exposure may be increased in diameter twenty-five times, without showing the granulations offensively. The influence of the structure of the collodion-film itself, too, is noticeable in pictures taken by the wet process; in the first place, being somewhat transparent, it permits a certain amount of lateral diffusion in the film, and a tendency to soften down the more minute details; and, in the second place, while wet it has quite a perceptible thickness, which is much diminished in drying, and the relation of the silver particles to one another changed.

I have attempted to avoid the faults connected with structure of the film by substituting dry collodion, and more particularly tannin plates for the wet. But though during the exposure to the celestial object the sensitive plate presents a glassy surface of extreme thinness, yet an indispensable preliminary to evoking the latent image is to soak the plate in water, and this introduces the more injurious of the two objections above urged. It was while trying this process that I ascertained the advantages that arise from warming the film during development,—the "hot-water process," as it is called. The attempt was also made to daguerreotype the original pictures at the focus of the telescope on silver plating, and also on *silvered glass*. In this case all lateral diffusion is entirely prevented, the light acting on a mathematical surface, and the relations of the film of silver to the glass not being disturbed by the subsequent manœuvres. But practically no advantage has arisen from these trials, because, as in the former instance, the whites in the resulting picture are not formed by a continuous stratum of mercurial amalgam. That this is the case is proved by the fact that such daguerreotypes can be copied by the electrotype, or a coating of isinglass, as was shown by Dr. Draper ('Phil. Mag.,' May, 1843). This is the first occasion on which silvered glass has been used for photographic purposes, and it may be well to point out its advantages. Owing probably to the perfect purity of the silver, it takes the coatings of iodine and bromine with uniformity all over; in silver plated by fire on copper, there used to be a tendency to insensitive spots, from the copper alloy coming out on the face of the silver, and so great was the annoyance, that, when my father was engaged in the experiments that led him to take the first portrait ever obtained from life, he was compelled to use sheets of pure silver alone. The light also seems to be able to impress the iodo-bromide in less time, and pictures of a rosy warmth are generally obtained. The only precaution necessary in practising this method of daguerreotyping is to fix the plate—that is, dissolve off the excess of sensitive material—with an alcoholic solution of cyanide of potassium, instead of an aqueous solution of hyposulphite of soda. The latter tends to split up the film of silver from the glass here and there, while the former does not. The subsequent washing, too, is most safely conducted with diluted common alcohol. The time of exposure is not, however, as short as in the wet-collodion process, at least six times the exposure being demanded; while if less is given, and the development over mercurial vapour be urged beyond the usual point, minute globules of mercury stud the silver all over, and ruin the proof.

The faults arising from atmospheric disturbances are easily understood. If an image of the planet Jupiter produced by a large telescope be allowed to move across a sensitive plate, and the plate be then developed, a dark streak nearly of the width of the image will appear. If this streak is closely examined, it will be observed that the passage of the planet seems to have taken place in an irregular way—by fits and starts as it were, and that

instead of the mark being continuous like that of a pencil, it rather resembles a string of beads. The cause of this lack of continuity is to be found in the movements of the Earth's atmosphere. Or, if the eye is placed at the eyepiece of the telescope, and the edge of a planet or the moon watched, it is found to present a wavy outline instead of a sharp disc-like appearance. Any point in the surface, too, is seen to have a rapid vibratory motion.

Although the eye can emancipate itself to a certain extent from these disturbances, a photographic plate cannot. Every point tends then to assume a greater size and less distinctness than it should have, and if the night on which the trials are being made is very unsteady, the smaller details are so confused together that the picture is worthless. Occasionally, however, very still nights occur, when photographs of great beauty may be taken. In the interval between March and December, 1863, three such nights occurred, and on one of them the negative for the 3-foot was obtained.

It has been stated that there are no insuperable obstacles to the production of perfect celestial photographs,—that is, such as realize the full optical power of the telescope used. The atmospheric difficulty may be successfully combated by removing a large reflector from near the level of the sea to a considerable altitude, where a great part of the atmosphere is left behind. It seems to me that a suitable place for such a purpose would be the rainless west coast of South America, somewhere near the equator. Improvements, too, are continually being invented in photographic processes, and a considerable step is made when we find out what it is that we need. Quick methods are not so much required as those which will yield grainless pictures on structureless films, and unless the time of exposure could be so much shortened as to be but a small fraction of a single atmospheric pulsation, no particular advantage would be gained by their use.

The inducements to amateurs to prosecute the study of celestial photography are very great, and the apparatus required is such as any one of a mechanical turn may make. A great deal can and will be done in this branch of astronomy; and animated by the hope that many others may be induced to cultivate it, I have written the detailed account in the Smithsonian Contributions.

HENRY DRAPER, M.D.,
Professor of Natural Science in the University of New York.

The Brazilian Coal-fields. By Edward Hull, B.A., F.G.S.

THE immense empire of Brazil, occupying one-third of the continent of South America, with an area of upwards of 3,000,000 of square miles; considerably larger than Russia in Europe; watered by the largest river in the world, which with its tributaries is navigable for many hundred miles from its mouth; its western bounds stretching to the spurs of the Andes, and its eastern washed by the waves of two oceans—such a country as this would appear fitted to occupy the foremost rank amongst the nations of the Western hemisphere, provided its boundless resources were turned to account by an intelligent people, and civilization were advanced by wise laws. It is satisfactory to reflect, that while most of the surrounding republics—the shattered limbs of Spanish America—are tossed on the waves of anarchy, Brazil enjoys a peaceful government under a constitutional monarchy; personal freedom with political security; monarchical principles combined with popular rights. We notice these points in the government of Brazil, because they afford the highest guarantee of national progress, and the development of industrial pursuits. Nor are the raw materials necessary for the attainment of a high position amongst

the manufacturing communities of the world absent from the soil of Brazil.

The northern half of the empire is physically not unlike the plain of Northern Italy on a large scale. Covered with forests springing from a rich alluvial soil, and watered by the Amazon and its giant branches, it is prodigiously fertile. The southern half is hilly, and sometimes mountainous, and gives birth to the Rio de la Plata. One of the peaks of the Organ Range rises behind the harbour of Rio de Janeiro, to an altitude of 7,500 feet. These and the neighbouring hills contain minerals and gems in abundance, and the Government has, with great spirit, undertaken a mineral survey of these southern provinces.

It was once supposed that this great empire — rich in precious stones, and nearly all the metals, from gold to iron inclusive—was devoid of one natural product, useful, if not absolutely essential, to the full utilization of the other mineral treasures — namely, coal; but such a supposition was altogether erroneous, as recent investigations have fully shown. A writer in a recent number of the 'Quarterly Review'* for 1860, mentions (on what authority is not stated) the existence of a coal-field upwards of 60 leagues in extent, and 40 miles from the sea. Considering that Brazil has a seaboard of more than 2,000 miles, the description of the locality is sufficiently vague; but, as far as it goes, the information is strictly correct; this, however, is all that was known on the subject on this side of the Atlantic till very recently.†

To a countryman of our own, Mr. Nathaniel Plant, we are indebted for a full account, through his brother, Mr. J. Plant, Curator of the Salford Museum, of the position and resources of three distinct coal-fields which he has recently explored in the southern part of the empire; the largest presents some features of peculiar interest, which we proceed briefly to lay before our readers.

The first notice of these minerals seems to have been taken by Mr. Bonliech, son of the Governor of the province of Rio Grande do Sul, in which the largest of the three coal-fields is situated. This was in the year 1859, and it was probably through the report of this gentleman that the writer in the 'Quarterly Review' obtained his information. The matter, however, seems to have been lost sight of until the end of 1861. When Mr. Plant, who for several years had been examining the mineral districts of Rio Grande, in the service of the Imperial Government, determined to make a fuller exploration of the coal-district, and he has now sent to this country an account of the very remarkable deposits of mineral fuel he met with, together with those unbiassed witnesses—photographic views, and rock specimens.*

The Candiota field is the largest of three which have as yet been discovered. It extends from lat. 32° S. to 28° S., and is thus at the southern extremity of the province of Rio Grande do Sul. It is traversed by the river Jaguarao and several of its tributaries, along whose banks the seams of coal crop out. There are two great seams of bituminous coal, the lower being 25 feet in thickness, the upper part of which is shown in the sketch, and is separated by only a very few feet of shale from the upper bed (or series of beds), which is 40 feet in thickness.

* No. 216, page 338 in foot note.

† A correspondent of the 'Mining Journal,' No. 1484, states that "years since samples of the coals were sent to this country, and analysed by Dr. Percy." It may also be stated that specimens of coal from Brazil were shown in the Exhibition of 1862, and were reported on by Mr. W. W. Smyth, in Jury Reports.

* These have been laid before the Geological Society of Manchester by his brother, 1864.

Portion of Escarpment, showing the outcrop of the Coal-seams along the border of the Candiota Coal-field. Taken from a Photograph.

In some places, the intermediate bands of shale which separate the mineral into distinct layers thin away, in which case a solid seam of no less than 65 feet is formed, unsurpassed, we believe, in vertical dimensions by any similar formation yet discovered. We have handled specimens of the coal; and though taken from the outcrop, it is scarcely distinguishable, except by a slight brownish hue, from the ordinary coal of our own country.

The coal-strata repose on a series of shales, sandstones, and crystalline limestone, the whole of which are supported by mica-schist, and finally by syenite.

Iron is also present, as in the coal-formation of Britain, both in the form of bands of clay-ironstone, and as a roof for the seams of coal. At the top of the cliffs formed by the outcrop of the coal-seam there occurs a mass of silicious iron-ore, several yards in thickness, a sheet-casting from which was sent to the late Industrial Exhibition amongst the other Brazilian products. Thus there occurs in close proximity to each other, the ore, the fuel, the flux, and the clay, necessary for the establishment of iron-furnaces.

The several minerals thus united rise in the form of an elevated escarpment (a portion of which is represented in the engraving), which may be traced for several leagues, affording the utmost facility for working by open-work, or tunnels driven into the sides of the hill. From its base stretches a gently sloping plain of basalt, over which a railway to a port in the Rio Gonzalo might be laid down at a very moderate cost. Sailing-vessels of 100 tons burden can navigate this river to the town of Jaguarao, 20 miles from the borders of the coal-field, between which and the important port of Rio Grande de San Pedro, on the Atlantic, there is at present a flourishing trade.

The second coal-field which has been observed, lies about 100 leagues to the north of the Candiota field, in the valley of the Rio dos Ratos, near Porto Alegre, the capital of the province. It is not of large extent, but well situated for carriage by river and lake; nothing has, however, yet been done to develope its resources.

The third coal-field is in the small province of San Catharina, lying north-east of the Rio Grande do Sul. It is reported to occupy an area of about 80 square miles, in the midst of a range of hills, and is not so accessible to commerce as the other two tracts.

It is not improbable that each of these coal-fields, lying as they do in a direct line parallel with the coast, is of the same geological age; and after an inspection of the fossil plants which have been sent over to this country, there cannot be a doubt, we think, that this age is the Carboniferous. Mr. Plant has

sent over several pieces of ironstone, on which are imprinted very distinct specimens of *Lepidodendron*, and several ferns not unlike those of the coal-measures of Britain. A gentleman, also, who has studied the coal-measures of Nova Scotia, which are of the same age as those of Britain, refers, in a letter which we have seen, to fine specimens of *Sigillaria* and *Stigmaria*, both of which are characteristic of this period. Specimens of these, however, are not in the collection we have examined, but nothing can be more distinct than the fronds of Lepidodendron already referred to. While on this subject we may be allowed to remark, that although, on the authority of Professor M'Coy, the age of the Australian coal-fields was for some time considered to be Jurassic, the recent investigations of the Rev. W. B. Clarke go to establish the Carboniferous age of these beds. Mr. Clarke has sent to England a collection of fossils from the New South Wales coal-field,* containing specimens of *Lepidendron* and *Spirifer*; and thus it would appear that, during the same great epoch, so pre-eminently carboniferous, deposits of coal were being elaborated over both hemispheres and on both sides of the equator; a marvellous instance of the uniformity of nature's operations in early geologic times.

The importance of these great deposits to the commerce of the eastern seaboard of South America need not be dwelt upon. At the present time, 250,000 tons of coal are annually imported into Rio Janeiro, at a cost of 49*s.* per ton, and from this depôt other coast-towns are supplied. When once the coal-field of Candiota is opened up, the Brazilian Government may be supplied at less than half the price, and our own little Island be spared the doubtful honour of providing fuel for a continent on the other side of the globe.

EDWARD HULL.

* In the Museum of the Geological Society of London, Somerset House.

Malt as Cattle Food. By J. Chalmers Morton.

STREATLEY, *near Reading.*

YOUR agricultural chronicle will doubtless place before your readers the fact that a bill has been introduced into Parliament, which will probably pass into law, for permitting the use of malt duty free in feeding sheep and cattle. They may, however, wish to know the probabilities of this measure proving agriculturally serviceable, more in detail than the limits of the chronicle will enable you there to discuss them.

The measure has probably originated in the interview with which the Chancellor of the Exchequer honoured a deputation of the Central Farmers' Club early last year, when Mr. Booth of Warlaby, Mr. Arkell of Swindon, and Mr. Williams of Baydon, all well-known agriculturists, declared to him that malt is greatly superior to barley as food for cattle and for sheep; and when Mr. Williams in particular put the case of an English farmer who had fed 300 sheep on a lot of spoiled malt, and was refused a drawback of the duty, though this would have been allowed to him had he exported the malt to a French farmer, who might thereafter have sent his sheep, fattened on this very malt, for sale at Smithfield. "Thus, while the foreigner might have the advantage of feeding his sheep on malt without paying any duty, the British farmer, if he wished to feed his sheep on malt, was subject to a tax of 21*s.* 8*d.* per quarter." The inconsistency of this was obvious enough to the logical mind to whom it was thus presented, and accordingly we have now a Bill which will for the future put an end to so great an anomaly! Barley may, for the future, in houses set apart for the purpose, be malted; and the malt may be dried and ground, with 10 per cent. of linseed, to a certain degree of fineness, and it may be thereafter sold under certain conditions, duty free, for feeding purposes. And no English farmer will hereafter be able to complain

that he is being undersold in the meat market by foreign mutton more cheaply fed than his own. Will this lead to any cheapening of the meat manufacture here? I think not.

What are the circumstances? On the one hand, we have the practical experience only of the few men who, in spite of the duty hitherto, have used it for the purpose of putting the last finish to the fattening process, when the pampered appetite of the animal intended for exhibition refuses everything but an unusual dainty. Liebig also writes to Mr. Bass, M.P., a letter, which may, however, be quoted by either party to the discussion, but referring especially to the greater digestibility of the malted barley. The letter is as follows:—

"In forming a judgment on the feeding properties of malt, when given to horses, cattle, and sheep, it is obvious that in comparing it with barley we must not lose sight of the fact that there is a larger amount of nourishment in barley than in the malt manufactured from it; for in the process of malting barley suffers a loss in weight amounting to from 7 to 11 per cent. of dry substance. The 'rootlets' constitute 3 to 3½ per cent. of this loss, and as they contain a pretty large quantity of blood-forming (nitrogenous) matter (25 to 30 per cent.), the grain, by their separation from it, undergoes a loss of one of its nutritive elements. Hence it is clear that if in practice the feeding qualities of malt are found to be greater than those of barley, this can only arise from the circumstance that the nutritive matter contained in malt is present there in a more soluble, more digestible state than in barley; and that therefore in feeding with barley more nutritive matter leaves the body in an undigested state than is the case when an equal weight of malt is used as food. There can be no doubt whatever that in malt blood-forming matter is contained in a more soluble form than in barley; for the process of malting occasions a loosening of the component parts of the grain in so great a degree that 100 volumes of dry barley yield (notwithstanding the loss of weight) 112 to 114 volumes of dry malt. Such a loosening of the inner parts of the grain, thus enabling the gastric juice in the animal body to penetrate it more easily and thoroughly, is not to be attained in like degree by a mechanical process. The comparative analysis shows finally that the amount of readily soluble blood-forming elements in barley is 1¼ per cent., and in malt 2·2⅛ per cent. By the process of drying in the kiln, a part of the soluble blood-forming elements is rendered insoluble, and from this it cannot add to the feeding capabilities."

On the other hand, there is, in addition to the considerations against the economy of malt which this letter urges, the fact that in the case of ruminating animals, for which the farmer will principally use it, there can hardly be any room for the idea that increased digestibility will prove advantageous. Indeed, the increased solubility of the food, especially, mixed, as it will be, with linseed meal, will tend to its passage with wasteful rapidity through the digestive organs. And there is also the fact that a very great waste of substance takes place in malting. If barley after being malted will occupy a rather larger space than it did, the loss of weight per bushel is in great excess of any advantage there. The loss of weight on the whole does indeed generally exceed 20 per cent., and this is too large to be counterbalanced by any improvement the substance may have acquired, whether in digestibility or otherwise, during the process.

Apart, however, altogether from the relative merits of barley and malt as food for cattle and sheep, there are cheaper and better foods now in use than either of them will ever be. Except in pig-feeding, where barley is the chief food used, it is of but little service in our meat manufacture. Oilcakes of various kinds, peas, beans, linseed, carob

pods, oats, and even wheat, must be named before it on the list of foods for the stable, feeding stall, or sheep-fold. And, if the mixed malt and linseed, both of them relaxing substances, which are offered to him duty free, be experimented on by the cattle-feeder, he must add a large proportion of bean meal, or some other astringent substance, to correct a tendency which will rather check than help the fattening process; while if used merely to induce the saccharine fermentation in other meals, which would form the bulk of the food administered, the small quantity wanted for that purpose is not worth the legislation which has been demanded for it. The real object of the existing agitation on this subject no doubt is, that we may have malt free for man. And the point, practically worthless and unimportant, but theoretically indefensible, which was pointed out by Mr. Williams to Mr. Gladstone, and on which the present Bill is founded, will have served a useful purpose if it shall in any degree have helped to remove what is undoubtedly a demoralizing, and, excepting to the tenants of good barley-growing districts, a generally mischievous impost.

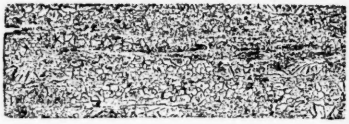
J. C. Morton,
Ed. 'Agricultural Cyclopædia.'

March, 1864.

A New Method of Illustrating the Structure of Blister Steel, by Nature Printing. By H. C. Sorby, F.R.S.

Broomfield, *near Sheffield*, *March*, 1864.

When iron is converted into steel by cementation, three distinct crystalline compounds are formed, two of which are readily dissolved by diluted nitric acid, whereas one is scarcely at all affected by it. If, therefore, a piece of such steel be ground flat and polished, and then placed in the acid, after a suitable amount of action, this constituent retains its original surface and polish, whereas the other two are so much dissolved that it stands up in sufficient relief to allow of the blocks being used for surface printing instead of a woodcut, to exhibit the structure of different varieties of steel. At the late conversazione of the Sheffield Literary and Philosophical Society, specimens were printed showing the appearance of a square bar of iron once converted (transverse section), iron remaining in the centre; a flat bar of iron, slightly converted, the crystals being small; a square bar of iron twice converted (transverse section), showing the centre incompletely converted; a flat bar of iron, highly converted, the crystals being rather large; a round bar of "homogeneous metal," converted (transverse section); and a flat bar of hammered cast steel, reconverted, the crystals being very large. In order that you may convey to your readers some idea of the appearances thus presented, I send you herewith a small block of prepared metal, capable of being employed as a woodcut.



It is a transverse section of "blister steel," from a flat bar of iron highly converted. The best method of viewing the prints is by mounting them as stereoscopic objects, for they appear to great advantage under such a magnifying power. Though far more suitable for blister steel than for any other metal, yet still prints may be obtained from sections of armour-plates and other varieties of iron, which show certain peculiarities in their structure in a very satisfactory manner.

H. C. Sorby, F.R.S., &c.

Books received for Review.

From *Messrs. Longman & Co.*:—

THE STORY OF THE GUNS. By Sir J. Emerson Tennent, K.C.S., F.R.S. Illustrated. 400 pp. 8vo.

ELEMENTS OF PHYSICS, OR NATURAL PHILOSOPHY. Written for general use in plain or non-technical language, by Neil Arnott, M.D., F.R.S., &c. 6th and completed Edition. Part I. 430 pp. 8vo.

A GUIDE TO GEOLOGY. By John Phillips, M.A., LL.D., F.R.S., F.G.S., Professor of Geology in the University of Oxford. 5th Edition. Illustrated. 320 pp.

THE BATTLE OF THE STANDARDS; the Ancient of Four Thousand Years against the Modern of the last Fifty Years, the less perfect of the two. By John Taylor, author of 'The Great Pyramid, why was it built?' 100 pp. 8vo.

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